OBSERVATIONS

ON THE

DUTIES AND RESPONSIBILITIES INVOLVED

IN THE MANAGEMENT OF

MINTS;

CHIEFLY WITH REFERENCE TO THE RULES AND PRACTICE OF THOSE

IN INDIA.

WITH SUGGESTIONS FOR THEIR IMPROVEMENT.

BY

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"Laws, you know, are intended to guard against what men may do, not to trust to what they will do."

Junius to Sir W. Blackstone.

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PREFACE.

In the year 1844, the Honorable the Court of Directors of the East India Company, ordered the preparation of a code of uniform Regulations for the Government of the different Indian Mints, the rules and practice of which were in many points very dissimilar. In January 1846, at the time that I was compelled to proceed to the Cape of Good Hope, on account of ill health, no scheme for this purpose had as yet been proposed; and, owing to the great difficulty of the subject, it was unlikely that any regulations could be soon framed so as to give general satisfaction.

Under these circumstances, being strongly impressed with a sense of the great desirableness of the publication of some statement of the leading principles of Mint Management, I was induced, during my absence from Madras, to put the following Observations on paper, in the hope that they might be of service in the construction of a general and comprehensive system.

The subject is not an unimportant one, as will be evident if we reflect that the average annual value of the bullion coined in all the Indian Mints, amounts to between three and four crores of rupees, or millions of pounds sterling; so that any improvement, affecting essentially the economy of conversion, or providing a remedy for existing defects in the strict guardianship of the treasure, cannot be altogether undeserving of attention.

I should not, however, have presumed to offer any suggestions of my own on this occasion, had I not for seven years held an office which has long been remarkable for its elaborate and earnest discussion of Mint principles; and being convinced by the study of these discussions, as to the truth of certain views, which as yet are only partially, if at all, received elsewhere, and satisfied that their adoption would be followed by a great improvement in the economy of our Indian Mints, I felt it to be a duty not to refrain from making these views and principles known, as a contribution towards that thorough investigation of the subject which MUST precede any real adjustment of the laws upon a satisfactory footing; a contribution which I felt to be the more necessary and desirable, because it appeared very probable, that the ordinary course of events would lead to the establishment, without sufficient inquiry, of the principles and practice which have hitherto been followed in the Mints of Calcutta and Bombay, the defects of which do not appear to be generally known.

Indeed, owing to the obscurity which hangs about all Mint subjects, the important item of the wastage of the precious metal has been so little attended to, that we in vain look, even at the present day, for real practical evidence whereby to test the efficiency of systems of management; so that, should no other benefit ensue from this publication, I trust that the statement of the practical result of seven years' experience, showing that the amount of precious metal necessarily abandoned in the refuse is, in India, only the sixteen thousandth part of the whole value, two-thirds of which may be realised by public auction, cannot but be useful as a matter of practical experience, for future reference; more especially when this result is viewed in connection with the fact, that the trifling loss thus experienced,* ought to be more than counterbalanced by a net surplus on the account, nearly fifty times as great, or amounting to about one rupee in every thousand.

Judged in reference to its economy in the preservation of the treasure, the system followed in the Mints of Calcutta and Bombay, though for so many years administered by Officers of the highest distinction and ability, has certainly failed to produce results equal to what might have been expected, and I have elsewhere† declared my conviction, that the general introduction of it would

* Vide Appendix, end of para 8.

† In an official report upon the proposed new rules, dated 24th February, 1848.

involve an unnecessary sacrifice to the extent of 140 to 150 thousand rupees per annum, a large part of which, I believe, still remains to be saved by the adoption of more rigid means of scrutiny and adjustment. This does not altogether arise from any absolute necessity of waste inherent in the system established in those Mints, but is partly attributable to the fact, which practically amounts to nearly the same thing, that success in connexion with it requires indispensably an union and combination of favorable circumstances which in the great majority of cases it would be unreasonable and vain to anticipate.

I am far from supposing, that in offering the following suggestions on a subject so varied and extensive, I have done all that is requisite towards the establishment of complete and perfect rules. Much more, I am fully aware ought to be done. Many questions* require previously to be carefully

* As an example of these, I may cite the following, though it is impossible to make a complete list at present—1. As to the expediency of undertaking the parting of metals at the various Mints, and if so, the charges for the same. 2. The propriety of rejecting brittle bullion, except in a Mint coining by contract. 3. Whether it would not be advisable that the assay report upon coins should have the same signification as that upon bullion, so that 100 tolas of rupees should be equal in value to 100 tolas of standard bullion. 4. Whether it be not indispensable that all bullion be melted previous to receipt. 5. Whether the charges for this should not either be remitted altogether, or equalised at the various Mints. 6. Whether Merchants should be credited in whole or in part for the value of both metals, when they deliver silver containing gold, and gold containing sil-

discussed, and decided by competent authority, in order to bring about the *possibility* of correct legislation. Advantage might also be derived from all the past mistakes, accidents, and delinquencies of our Indian and other Mints, if measures were taken to have them searched out previous to the consideration of new laws; but this benefit must be lost, if the private history of all the Mints remain a sealed book to the constructor of a general system.

The considerations above mentioned have induced me to offer the observations which follow, to the few who take an interest in these subjects; and as my object is the accumulation of data for the future guidance of those who newly enter upon the subject, I shall feel it to be a great privilege if their publication should induce any who have had more extensive opportunities than myself, to correct any errors into which I may have fallen, or add to the facts to which I have referred, by communicating to me the results of their experience.

ver; and if so, to what extent. 7. Whether in mixtures of the precious metals, the silver contained in gold ought not to be ascertained by *actual recovery* rather than by the defective system now followed. 8. Whether all refining ought not to be done in the Mints, rather than that the Merchants should be compelled by prohibitory charges to undergo the risk of employing native refiners. 9. Whether in regard to gold which has no connection with the standard of value, and even when coined is a mere fluctuating article of commerce, the Merchants might not, under certain limitations, be allowed to choose the proportion of alloy added to it.

A writer on Mint subjects has, however, but scanty encouragement; for, owing to the extreme paucity in the number of those who are really interested in the matters he treats of, as well as the prevailing bias towards peculiar views of those who are, he has reason to feel assured that while his readers are but few, the great majority even of them may only read to disagree or to condemn. He who ventures to find fault with existing systems, as I have done, may even stand in a worse predicament; however, I am in hopes that, whatever objections may at first be made, the truth of most, if not all the principles I have advanced, will in time be acknowledged, though it may be long after I have quitted the scene of my present avocations; and as the object will thus be accomplished, though tardily, the benefit which will I trust be derived therefrom will satisfy all my expectations as to the result of my labours.

1*st May*, 1848. J. T. S.

OBSERVATIONS.

CHAPTER I.—*On the duties of a Mint in general, and of the different Officers connected with it. The checks to which the Mint is to be subjected, and the power necessary to be bestowed on the Mint Master.*

Duties of a Mint.

1. A Mint is an establishment provided by Government for the use of the Public, for converting the precious metals into the currency of the realm; the object being to encourage commerce, and facilitate exchanges as much as possible, by the ready transformation of the crude bullion, obtained by merchants in the course of trade, into the well known currency of the realm.

Employed by Government in the same way as by the Public.

2. The Mint is occasionally used by the Government itself, for the purpose of converting into currency the various coins of foreign countries or states which may be received in the collection of revenue, and in this case the Government only makes use of the Mint in the same manner as any private individual might do; but in regard to that part of the inferior or subordinate currency which does not constitute the measure or standard of value, (in England, composed of silver and copper, and in India of copper pieces or tokens,) whereof the intrinsic, is far inferior to the denominational worth, the

establishment works exclusively on account of the State, which reserves to itself the right of issuing such tokens, on account of the obvious mischiefs which the surrender of this privilege would occasion.

3. In civilised countries, where foreign coins are altogether rejected from use, and no species of money obtains currency but the authorised standard coins, the Mint has no other office to perform but that of converting the various invoices of bullion which are received in the course of foreign trade; and the Government has no occasion for its services except when it may be expedient for it to import bullion for its own financial purposes. In India, however, where owing to the large extent of the territory subject to British sway, we are brought into contact with many Independent States, some of which, even within our own boundaries, retain the privilege of coining, and innumerable others are connected with us by commerce, it is impossible to avoid the introduction of a vast number of foreign coins of all kinds; which, owing to the difficulties of communication, cannot be brought to the Mint for conversion, and from the want of intelligence and active enterprise in the natives would never find their way thither, but would remain as obstructions to the channels of circulation and the freedom of exchange, and the fertile source of fraud and exaction to the native shroffs, did not the Government interfere to hasten their removal. For these reasons the State has planned an admirable system for the purpose of maintaining the perpetual renovation of the currency, by making use of the Treasuries established in all the principal stations as a series of depots for the reception of uncurrent coins of all kinds, which are convertible into standard currency by the aid of a table of the values of foreign coins calculated by the Assay Master. The coins themselves, whenever a sufficient number has been accumulated, are from time to time sent down to the Mint for coinage. By this simple arrangement a series of absorbents, if we may venture to use the expression,

is kept in constant operation, by means of which, like the venous and arterial system of the natural body, the former conveying the impure blood to the lungs, the vital purity of the commercial stream is maintained, and the benefits of a local Mint are extended to every corner of the land; and thus an effectual stop put to much fraud and extortion, and great facility afforded in the collection of the revenue.

Necessary conditions of the right performance of the duty of a Mint.

4. The process of transformation is the duty and business of the Mint; which taken as a whole, may thus be compared to a vast instrument, or machine, for the conversion of crude bullion into standard coins; and we may observe that the work of this machine, or the duty of the Mint, is rightly performed when the whole value of the bullion committed to it is restored in coins strictly conforming to the standards prescribed by law.

There ought to be no waste in Minting.

5. We consider it beyond doubt, judging from the results of actual experience, that there ought to be no loss whatever by the process of conversion, in any of the Indian Mints; on the contrary, as we have elsewhere explained, (vide Appendix, paras. 54 to 64,) there ought to be a small surplus in the out-turn. In the discussion, therefore, of the duties and responsibilities of the different Officers of the establishment, we shall consider this as being admitted, because our object is to determine what the requisite checks are to ensure the business being properly executed; not what may suffice if it be imperfectly done, or slurred over.

6. Before proceeding, however, it may be advisable that we should first notice and obviate a misconception which has been suggested to us in reference to the above assertion, as it strikes at the very root of all the benefit of the important principle involved in it. It has been said, that it may be very true there ought to be no waste, or even a

This fact is not dependent on the recovery of the drosses.

slight surplus in the re-delivery of the precious metal entrusted to a Mint, provided it were possible to extract all the particles from the mass of refuse wherein they are buried; that by pushing the recoveries to an extreme length, in defiance of all real economy, it may be in fact possible to exhibit a trifling overplus, though the cost of the extraction of the last particles may have far exceeded the value of the metal; but that unless this reckless contempt of true economy be systematically persevered in, as it is clear that a certain amount of bullion must, of necessity, be allowed to remain untouched, on account of the expense of extraction, a waste must be unavoidable; so that however true in theory, it must be a fallacy in practice to say, that there ought to be a nett surplus of delivery, and an actual bonâ fide excess. This argument is, however, based upon a misapprehension of the truth it is intended to oppose, for the assertion is not, that there should be no metal not recovered, but that there should be no metal lost whose existence could not be proved, and its value recovered, if necessary. Further, that as a matter of actual practice, there ought to be a nett surplus of delivery, including the particles in the drosses, whether they be recovered therefrom or whether they be not, which is totally immaterial to the question; to which it may be added, that this excess ought to be so much larger than the value of all the particles which are not extracted from the refuse, that even taking the matter in the sense in which it is viewed in the objection, the assertion still remains practically true.

The objection founded on a mistake.

7. The principle and the practice we contend for is, that the out-turn of a Mint in coins, bullion, and drosses, ought to be *exactly* estimated, and compared with its receipts; and we affirm that if this be correctly done, and the duties of the Mint have been strictly and faithfully performed, throughout, the

As a matter of right system a balance ought to be made of receipts and issues.

former ought to exceed the latter, whenever the bullion is debited at the "trade Assay." Which being the case, we are of opinion that, as a matter of system, the comparison ought to be made, and the check thereby established, in preference to the more lax proceeding of omitting the comparison, and writing off all deficiencies to profit and loss as "unavoidable waste in the operations of coinage." The extent to which the extraction of the bullion out of the drosses ought to be carried, is another and a very simple question; the answer to which obviously is, that it should be carried so far, and no farther, than it would be attended by a clear profit to do so. In this way it is that the business is carried on in Madras, the refuse, when no longer capable of being "recovered" on account of Government, with profit, being sold, and the proceeds carried to account; and it is according to this scheme of practice, that the actual results which have been referred to have produced a nett surplus amounting to $\frac{1}{12}$ per mille.

The recovery of the drosses ought to be carried only as far as profitable.

8. To return, properly speaking the Merchant ought to receive his own bullion back again in its altered form, as is the case in England; but as it would be impossible to deal separately with the numberless small parcels of metal which are brought for conversion to the Indian Mints, the course pursued there, is that of returning to each Merchant an equivalent for his bullion out of the stock of coins contained in the coffers of Government, by means of an order payable at the Treasury, so that the State thus becomes the purchaser of the metal, the produce of which is returned to the Treasury in lieu of the payment made. It thus happens that if there should chance to be any *waste*, or loss in the operations of the Mint, in any or all of the parcels of bullion manipulated, it is not discoverable at the time, owing to the unavoidable necessity of working the various parcels of bullion together, and the impossibility of ascertaining, except by a gen-

Merchants ought properly to receive back their own bullion, but this impracticable in Indian Mints.

Waste is not discoverable at the time of its occurrence.

eral settlement of accounts and clearance of the Mint, what the exact balance actually in its possession, or value of the precious metal within the premises, amounts to.

Government suffers the loss if there be any waste in coinage.

9. When a settlement however is made, if a deficiency is found to exist, and written off as "unavoidable waste in the operations of coinage" the loss falls upon the State, which has no opportunity, and indeed would have no right to demand compensation from the Merchants, having already taken from them a payment in lieu of all the expenses of coinage.

Nature and amount of "seignorage."

10. This payment, which is called "seignorage," is a distinct charge upon all the bullion coined, at a certain rate per cent upon the value, (in India 2 per cent upon silver, and 1 per cent upon gold) and it is intended to meet and cover the charges of conversion, which are in the mean time advanced by the State. It is probable that it does so in most instances, though the cost of fabricating small coins considerably exceeds the seignorage. But at the same time it must be observed, that the Mints established by any Government ought not to be looked upon in the light of sources of revenue; and therefore it is only desirable that, on the whole, the aggregate income of all of them should cover their gross outlay. In addition to the seignorage there is a charge in the Indian Mints for the refinage of all silver coarser than 6 dwt. weight below "Standard," at the rate of 0·04 per cent per dwt. of coarseness; and gold at the rate of ½ per cent. for every 5 carat grains inferior to standard.

The Mint is not a legitimate source of Revenue

Duties connected with the Mint which the Government is bound to attend to.

11. On considering the relations between the Mint as a Government establishment, and the Public for whose use it is maintained, and the duties which arise out of this relation, we are led to perceive that the latter are not exclusively confined to the Officers of the department itself; and that,

irrespective of the general obligations whereby a Government is bound to see to the well-being and efficient management of all its Institutions, there are duties which it owes to the mercantile community in regard to a Mint which have a special claim to its attention, and which cannot with justice be left unattended to. These relate to the securities which it behoves it to maintain "ab extra" for the faithful discharge of the business of the department, by the institution of proper and efficient checks; and the provision of such facilities for the transaction of the business, as may enable the Merchants in all their dealings with it to obtain perfect and satisfactory assurance that justice is done to them.

Protection of the interests of the Merchants.

12. There are two points in particular, in respect to which the Government, as guardian of the interests of the mercantile community, is imperatively called upon to provide the fullest security; by the maintenance of efficient and satisfactory checks. Namely, for the purpose of securing

Two duties required.

First. That all bullion brought to the Mint be fairly and exactly valued, and that the Merchants receive the whole amount of that value, on payment of the legal charges for conversion, or "seignorage."

Check upon the valuation of bullion.

Secondly. That the coins issued to the Merchants or to the Public, be in exact conformity to the Standard prescribed by law, in weight, fineness, &c. &c. &c.

Do. upon the fineness of the currency.

13. There are also other points, but of comparatively minor consequence, such as the economy of the current expenditure, the artistical execution or "finish" of the coins, and precautions against forgery, which require to be attended to, and included in the instructions of the Executive Department, which

Responsibilities of the Executive Department of a Mint.

may accordingly be described as holding the four following chief responsibilities, viz.

First. As to the safe custody, and exact re-delivery of all the bullion entrusted to it for coinage.

Second. As to the exact conformity of the coins to the "Standards," in weight and fineness prescribed by law.

Third. As to the economical management of the current expenses of the Mint.

Fourth. As to the beauty and finish of the coins.

Officers connected with an Indian Mint.

14. The chief Officers attached to the Indian Mints, and under whose care and management the whole of the business connected with them is transacted are, the Mint Committee, the Mint Master, and the Assay Master. The following is a brief outline of their respective duties.

Mint Committee, their duties.

15. The Mint Committee represent the Government, and, acting on its behalf, is charged with the duty of seeing that the precautions which it is the province of the Government to take are carefully attended to; and that the chief responsibilities connected with the business of the Mint are strictly checked and duly acquitted by the Officers in whom they are vested—the Mint, and Assay Masters. They are also Auditors of the accounts, and referees upon all those points which are not specially provided for by the regulations. It is thus the duty of the Committee to see that the Rules established by the Government are regularly enforced, and to suggest amendments if it should be evident that they are insufficient to secure the interests of all the parties concerned; but the Committee do not themselves bear any part of the executive responsibility, and therefore have no share in the executive management; their office being entirely of a judicial character. In other words, it is the office of the Committee to test the results attained by the departments subjected to their scru-

tiny, by means of the established checks, and report the same to the Government, but not to interfere in the direction of the agency whereby those results are arrived at. All interference and control we conceive to be out of the question, if it be intended that the Executive Department shall be strictly responsible.

16. Were the duties and responsibilities of the Mint and Assay Masters clearly defined and separated from one another, so as to put a stop to interference, and the unpleasant discussions arising therefrom, and to leave no doubt to whom blame was to be attributed, on all occasions when errors in the results have to be accounted for; thus obviating the occurrence of those lengthened explanations, which, under a confused system, give so much trouble, though they rarely succeed in giving satisfaction, the business of the Mint Committee might be reduced to a very trifling amount, compared with what it usually is at present; for the accounts now rendered by the Mint admit of considerable reduction in volume, with great addition to their clearness and efficiency as a means of check; and some saving of expense, besides a great increase in the regularity of the duties of the Committee would be brought about, if that very desirable object were attained. And the time seems now to have arrived when sufficient materials may be found in the varied experience of all the Indian Mints, for the preparation of a system of Rules distinctly defining the responsibilities of the two departments; and comprehensive enough to embrace all the cases of reference which have been the subjects of discussion in past years.

The labour of the Mint Committee might be reduced by simplification.

Sufficient experience procurable for the framing of comprehensive Rules.

17. Thus simplified, the duties of the Mint Committee, instead of being an irksome and very grievous incumbrance to the Officers who perform them, would become, what they are always meant to be; duties of considerable importance,

Trouble saved by this.

and therefore entrusted to confidential agents, as constituting the only safeguards against risks of vast magnitude; but, with the assistance of a Secretary to the Committee, who we think ought to be remunerated for his trouble, requiring but little personal attention, and that only on rare occasions.

18. There are usually three members of the Mint Committee, chosen from amongst the heads of the principal departments of Government, with a Secretary, and they decide all the questions which come before them according to official representation. Many of these subjects, however, which, as matters now stand, are referred for their judgment, are of such a technical and abstruse character, and require the consideration of so very many particulars relating, either to the history of past transactions, or the chemical and mechanical theory of the processes to which the precious metals are subjected in coinage, that it is not to be thought wonderful if, on many occasions very erroneous opinions are formed respecting them by gentlemen who can only devote an occasional attention to these subjects, and whose chief study must be given to the duties of their own departments. On this account, as the characters of the Mint and Assay Masters, as heads of their respective offices, are so much at the mercy of the decisions which may be recorded by the Mint Committee, it is hardly just that they should have no opportunity for explanation, in those cases wherein a wrong view may have been taken of their proceedings; and to obviate this, we think it would be desirable that these Officers should be honorary members of the Committee, and thus be enabled to enter any explanation which may seem to be requisite, in reference to the recorded statements or opinions; though they might be excluded from the right of attending meetings, or giving a vote upon any questions, unless specially invited to do so by the proper members of the Committee.

The decisions of the Mint Committee sometimes grounded on imperfect information.

The Mint and Assay Masters ought to be honorary members of the Mint Committee.

19. We are doubtful whether the appointment of "ex-officio" members to a Committee, whose duties, as matters now stand, are so difficult as well as important, is so good an arrangement as it has been supposed to be; at all events, there can be no question that an occasional deviation therefrom, for the purpose of securing the assistance of experienced Officers, would be an improvement. Were the rules more definite and exact, and the business thereby as much simplified as it might be, this would perhaps be of less consequence; but we think it very desirable that these appointments should not be exclusively held by Officers overwhelmed by other duties, to the exercise of which alone they rise by gradual training and experience; since by this arrangement they find themselves suddenly called upon to perform, without an hour's preparation, the mature functions of an office, requiring at least as much technical acquirement and skill as any post under Government. It ought also, in our opinion, to be a standing rule, that the Mint Committee should occasionally visit the establishment.

Duties of the Mint Master.

20. The Mint Master is the head of the Executive establishment, and charged with *all* the responsibilities above enumerated, (para 13.) of which he acquits himself by submitting the work and accounts of his department to the scrutiny of the Mint Committee, and examination by the checks established by law, which will be presently described. We are here speaking of him not in reference to the powers or responsibilities vested in him in either of the Indian Mints, for the practice differs in all three, but as the abstract representative of the head of the Executive Department, just as the Assay Master is the head of the Check Department. It appears to us clear that these two departments ought to be quite distinct in every Mint, and each complete in itself; we shall hereafter be called upon to decide how the Assays which are necessarily involved in the duties of the *Executive* Department, are to be performed.

21. To make the first and most important of the responsibilities of the Executive Department, as specified in the list above given, complete and obligatory, it is indispensable, not only that the Mint Master should be responsible for the management of the processes for the manipulation of the metals, and consequently the control of the necessary expenditure; and responsible also as to the accuracy and beauty of the work, but also that he should be made accountable for the custody and produce, and consequently for the valuation also of the bullion, in which responsibilities it is impossible for any other person to take a share.

Mint Master must be responsible for the value of metal entrusted to his care.

22. In truth, the responsibility as to the produce, is obviously inseparable from that as to its safe custody, during manipulation and at other times, respecting which there never was, we believe, any question; the chief difficulty being to realise the existence of a responsibility as to the custody and produce of the supposed *value*, without granting to the person holding it power to assure himself of the bonâ fide receipt of the value to be accounted for. As this question will be more fully inquired into hereafter, it is unnecessary to enter upon it in this place; we will therefore proceed to show what the duties are, which are involved in the mere custody of the precious metal, supposing the charge of it to have been fully made over; and the nature of the qualifications which are desirable in the Officer undertaking this responsibility, to enable him to perform them.

Must assure himself of the receipt.

23. It seems to be altogether superfluous to dwell upon the necessity for a thorough knowledge of metallurgy, and practical mechanics, in the Officer charged with the management of such a manufactory as a Mint; as it must be obvious, that without these qualifications, he must be utterly incompetent to direct processes which are wholly dependent upon these arts for their successful accomplishment; but the

The Mint Master ought to be qualified in metallurgy and mechanics and chemistry.

advantage of a knowledge of the principles and practice of chemistry, as an invaluable aid in the performance of a Mint Master's duties, being not quite so apparent, we shall make a few observations on the subject.

Reason why a knowledge of chemistry is desirable.

24. The art of coining is in the abstract empirical, and, were it practised on a small scale, and without reference to expense, would, when once followed successfully, be, as a matter of course, easily pursued for ever afterwards; but as bullion of all kinds has to be operated on in the large way, some qualities of which contain as alloy, metals of all kinds in endless variety of proportion; and as some of the processes also, especially the refinement and separation of the precious metals, require the use on the large scale of chemical agents, which can not, except at an unwarrantable expense, be procured in a pure state, the Officer in charge of the bullion is liable to be met by many serious and perplexing difficulties, if he be earnestly striving to perform his paramount duty, in searching out and putting an end to every cause of apparent waste, owing to the new and unexpected combinations which are apt to take place, and the risk of part of the precious metal being either overlooked in some unexpected form, or of its being dissipated and lost in the attempt at recovery.

Do. do. do.

25. As all these difficulties are essentially of a chemical nature, the Mint Master ought either himself to be competent to their investigation, or at least have the assistance of a qualified person to do so. The latter, in the absence of the former, we consider to be the least satisfactory arrangement; for the safe preservation of the bullion, when we understand by that term the *exact* custody of it, in an Indian Mint, depends entirely upon the thorough searching out of those deep laid artifices of deceit and villainy, whereby the native workmen will endeavour to gloss over and hide their nefarious practices; and which nothing

but a resolute determination to sift every process to the very bottom, so as to leave them not a crevice to hide in, can ever put an end to; and though we think it most probable that in the management of the extensive business of a large Mint, the head of the Office would have too much on his hands to be able personally to inquire into every difficult case by a chemical investigation; yet we think, that if competent to do so on emergency, and thereby possessed of the power of satisfying himself as to the truth, in any unusual case of discrepancy, he must necessarily be much more secure in holding the serious responsibility with which he is charged, than he would be if obliged to trust altogether to the zeal and ability of another.

The only method of checking frauds is by investigation of apparent waste.

26. How far it might be expedient to transfer the investigation of such cases to an independent Assay Master, experience alone could decide; but we may observe, that it is only upon the first adoption of a rigid system of account and management, that the difficulties above alluded to are likely to be met with; for if the principle of exactness in the accounts were universally established, the experience of a few years in the different Mints would be sufficient to get rid of all such questions; each one as it arose being cleared up and disposed of for ever; so that in the end they would cease to arise, and the safe custody of every fraction of the precious metals would be reduced to certainty.

It is preferable that the Mint Master should have power to make investigations himself, rather than depend altogether on another.

27. As an illustration of the kind of question to which we refer, we may mention that in the common process of refining silver by cupellation, there is a certain loss of precious metal which, after every pains that can be taken, we have not yet been able to reduce below ½ per mille. It is not a loss of metal thrown away in the drosses or refuse, for after allowing for the

Illustration of the kind of investigation referred to.

precious metal contained in them, the deficiency still remains. It is not carried away with the smoke; at least no trace is discoverable on examination by chemical tests, and the question has still to be solved what becomes of this ½ per mille. This appears to be one of the kind of questions which only requires a thorough investigation to yield a satisfactory answer, but there are other similar ones; and we are of opinion, that until they are all thoroughly probed to the very bottom, the duty of the Officer in charge of the precious metal is only partially fulfilled.

28. In the particular case above cited, it might be the result of the inquiry that the silver was dissipated in a way that could not be prevented, though we think this very improbable; its *annihilation* we know to be impossible. It might be, that the expense of prevention would exceed the value of the metal saved; or, on the other hand, the cause of waste might be discovered to be one easily remedied, and the loss put a stop to. We think it of less consequence which of these answers should be met with, than that the principle should be established, that in every case of a deficiency of the precious metal it should be made unquestionably certain *what* had become of it; because we think, that when once it is permitted to be deficient *no*-where, we open a door to frauds which it were vain to attempt to hinder the natives from taking the largest advantage of.

The object more that of *accounting* for the absence of the bullion than of recovering it.

Bullion ought not to be allowed to be deficient without a knowledge and proof of the cause.

29. And this we are of opinion ought to be the course pursued in respect to every part of the progress of bullion through the Mint. To talk of the annihilation of metal we know to be absurd, to listen to its being absent without knowing *where*, is to connive at fraud, and hence if, after counting all that is contained in the drosses, (whether it be recovered therefrom or not, which is immaterial, provided it be

*proved** to be there) there be not a correspondence between the receipts and deliveries (which involves a nett surplus according to the accounts) we can only say, that the proof is unexceptionable, that the business of some part or other of the establishment has been ill performed, and requires amendment.

If the receipts and issues do not correspond there must have been error.

30. The Assay Master is the agent of the Government, and on its behalf of the Mint Committee, and is employed as an Officer of check in testing the operations of the Executive Department, with a view to their forming a judgment of the accuracy of the work, and the completeness of its acquittal of the responsibilities laid upon it, in respect to the first and second of the points above mentioned, (para. 13,) viz. the completeness of the restoration of the bullion, and the exact conformity of the coins to the Standard. The part in which the Assay Master's services are most necessary is in testing the fineness of the metal in various stages, which is effected by assaying, a process very simple in its general character, and demanding but little skill or attention to perform it in a *rough* way; but requiring great care and much patient dexterity and experience, to ensure that precision and accuracy which are essentially requisite for the proper performance of the duties connected with a Mint.

Duties of the Assay Master.

This duty is assaying.

31. The Assay Master has a separate establishment independent of the Mint, whose business is exclusively that of assaying; and his *sole* responsibility is for the truth and accuracy of their work, and of the reports founded thereon; and *nothing more;* a fact, which it is important to show, springs from the obvious truism, that each department can only be ac-

Assay Master is only responsible for assaying.

* In Madras, the Assay Master minutely examines every dross, and estimates the value of the gold or silver contained in it.

countable for its *own* work; because, owing to the difficulty of drawing the line of separation between the duties and responsibilities of the Mint and Assay departments, the Assay Master has by some been held to be accountable for the proceedings of the Mint; more especially as to the fineness of the out-turn of its meltings and coinage; and great confusion has arisen therefrom.

There are two distinct series of assays in every Mint.

32. This difficulty has been increased by the want of attention to the fact, that there are two entirely distinct series of duties of assaying connected with every Mint; one relating to the assays made in behalf of the establishment; to enable it to perform its duty and secure it from loss, which we may call the "executive" series, and the other which we may call the "check" series, on the behalf of the Government, and as a check upon the first; to secure that the business of the establishment is rightly done, and that the important trusts committed to it are fully and faithfully acquitted. It is obvious that these two series are distinct, and ought by no means to be confounded together, nor united in the same person, being in fact incompatible. The latter are the proper duties of the Assay Master, who is strictly an officer of check; the former ought to be executed by a member of the Mint establishment.

In some Indian Mints the Mint Master is destitute of power to value either his receipts or issues.

33. The neglect of this distinction utterly vitiates the attempt to realise a distinct and tangible responsibility in the Mint, as to its receipts and issues; and alarming as this may sound, we cannot wonder at it, when we reflect upon the anomaly, that the Head of a vast establishment like the Calcutta Mint, whose yearly accounts involve the value of from two to three millions of pounds sterling, is unprovided with the means of ascertaining, either the exact value of the bullion entrusted *to* his department, or of that taken from it; except by reference to the reports of a department per-

fectly independent of his authority; and which, though performing a process confessed to be liable to frequent errors, and subject to a constant temptation to, and facility to commit extensive frauds, is subject to no check, and liable to no question.

34. This is not the place to enter upon a discussion of the merits and defects of the various systems in force in the different Indian, and other Mints; we shall therefore at present merely observe, that it is an indispensable condition to the establishment of a right system, that the bullion handed over to a Mint be valued by an Officer of its own. Some *one* person ought to be made responsible for the safe custody and produce of the metal, before it is subjected to the manipulative changes which temporarily conceal its value, until the completion of the transformation into coins.

The first step in *real* responsibility is *satisfaction* as to receipts.

35. Now, the vital ingredient in this responsibility is, that the Officer holding it must be *satisfied* that he receives the bullion he is accountable for. *How* this may be effected is immaterial; but if it be omitted, it is impossible for any *real* responsibility to be held by the Mint establishment; and although, as in Calcutta, the Mint Master may be nominally vested with the responsible custody of, and obligation to restore the bullion entrusted to the Department, this obligation is obliged to be qualified by the exception of the "unavoidable waste in the operations of coinage," without which reservation, he would be in a situation of the greatest danger.

Without this the responsibility as to charge must be *nominal*.

36. It is obvious, however, that this exception, although absolutely indispensable, in justice to the Mint Master, under such an arrangement, virtually betrays the interests of the Government upon whom all the losses fall; because, setting aside the fact, that under a proper system no exception at all is necessary, it must be evident, that if the department be only considered

Allowance of waste annihilates all strict check.

accountable for the restoration of all the bullion entrusted to it, *minus* what has been lost, or made away with in the processes, it is in fact subject to little or no responsibility at all.

37. Further reasons will hereafter be shown for the necessity of a separate and independent series of assays from those of the Assay Master, (though not necessarily by another Officer,) but before quitting the subject of the impropriety of their being confused and united in one person, we may point out how clearly this is illustrated in affairs of commoner experience. For instance, we should consider it absurd if a Treasurer were expected to be responsible for the charge of money, while he was prohibited from counting either his receipts or payments, and obliged to take them upon the word of an Officer totally independent of his authority. All the mistakes created by the negligence or inaccuracy of this Officer would only be manifested in the final deficiency of the Treasury; and if it were known that errors were frequent, and sometimes of serious magnitude, would it not be foolish to expect that the Treasurer could be responsible for them? The idea is preposterous, yet such is precisely the situation of a Mint having its receipts and issues valued by an independent Officer; and it is equally true in either case, that the attempt to engage two distinct persons in a single charge, neutralises the responsibility of *both* of them. The independent Officer cannot be responsible for the deficiencies of the Treasury or Mint, because he cannot answer for the custody of the cash or bullion; and the Treasurer or Mint Master cannot be answerable, because he has never been satisfied as to the money or value of bullion supposed to have been received; nor assented to the payments made on his account. These duties must be united in one responsibility, or there is no *real* responsibility at all.

Illustration of the impropriety of separating the responsibilities of valuation and custody.

The employment of two persons in one charge ruins the responsibility of *both*.

38. If we trace the history of a parcel of bullion, handed over to a Mint for conversion into coins, we see that from the moment of its being accepted by that establishment, to the time of its re-delivery, in the form of standard coins, it is under the sole charge and custody of the Mint Master; whose duty it is to watch over its manipulation, and provide for its safety, until the time when he can acquit himself of the charge. This is a distinct and single responsibility, and cannot be broken up or divided. The transformation sought by the Merchant is commenced immediately after the first delivery of the bullion to the Mint, and is not completed until the termination of the last process, immediately preceding its restoration; during the whole of which time the value is partially concealed from view, and cannot be exactly traced. Until the object is accomplished, it is evident that the Mint Master ought not to be relieved from his charge; and however needful it may be that internal transfers of the bullion, from one Officer of the Mint to another, should take place while it is under manipulation, the sole object for consideration by the Government, and the distinct responsibility of the Officer at the head of the Executive establishment, ought to be confined to its final delivery undiminished, in the condition prescribed by law.

During conversion the bullion is under the sole charge of the Mint Master.

39. While we insist, however, upon the necessity of the Officer entrusted with the responsible charge of bullion under manipulation, being thoroughly satisfied as to the receipt, we must not forget to observe that in this, as in every other purchase, there are two parties concerned; the buyer and seller, both of whom equally need to be assured that justice has been done to them. It follows, therefore, that the valuation of bullion cannot be made by only one person, unless it could be done in such a way that all parties could convince themselves of the accuracy of every step of it. Hence, although it is indispensably necessary on the receipt of

The Merchants ought to be satisfied as to the truth of the valuation of their bullion.

bullion into a Mint, that its valuation should be made, or checked by an Officer of its own, yet it cannot be left entirely to him, and something further is required in order that the Merchants also may be satisfied that their interests have not been neglected. Were it left to an Assayer acting on behalf of the Mint alone, he would be subject to a perpetual temptation to undervalue the bullion in order to secure the department from loss. It is, therefore, necessary either that the valuations, if made by him, should be checked and assented to by an Officer independent of the Mint, and acting on behalf of the Merchants; or, that the valuations should be made by an independent Officer, and tested and assented to by the Mint Assayer.* The independent Officer here referred to, we need hardly say, is the Assay Master.

Two Officers must therefore scrutinise the valuations.

40. Again, just as the concurrence of the Officers of the Mint in the valuation of bullion on receipt is essential to the integrity of their responsibility, as to its custody and produce, so is it also in regard to the issues from the department; that is, in the valuation of the coins sent into circulation; which we think is not alway attended to with all the accuracy and care that are requisite. This subject will, however, be more easily understood after an explanation of the method of valuation, and the nature of the processes connected with it; and we shall therefore postpone any remarks upon it, till we come to treat upon the responsibility as to the fineness of the coins, with which it is intimately associated.

The Mint Officers must be satisfied as to the valuation of the outturn.

41. We shall take the same opportunity of stating, both how the conformity of the coins with the Standard may be very exactly measured, and also how the true value of the issues of the Mint may be determined thereby; so that, upon

* In this manner the duty is carried on at the Royal Mint.

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Checks of the Mint made by the Assay Master.

the subject of the methods by which the various responsibilities of the Executive Department are tested, it will be unnecessary to say more at present, under the first, second, and fourth heads, before specified, than that the accounts of receipts and deliveries are made out according to the valuations of the bullion, coins and drosses, determined by the Assay Master; and the conformity of the pieces to the legal Standards is also tested by the same Officer's examination of the "pyx coins" after the delivery of remittances to the Government Treasury; and it will be seen on perusal of the suggestions which we shall venture to make on these heads, that the utmost rigour of exactness in checking the proceedings of a Mint is easily attainable. In regard to the "finish" or excellence and beauty of the workmanship, no special examination is necessary, since that particular is open to the observation of every one, and the pieces are in the hands of millions; but we may mention, that as regards the Indian Mints, the precaution is nevertheless taken, both to ensure attention to this point, and to guard against the risk of any negligence or defect in the operation of the local check, as to the Standard fineness of the coins, of causing specimens from time to time to be selected by the Secretary to the Mint Committee, and transmitted to the Honorable Court of Directors, by whom they are placed in the hands of the Assay Master of the Royal Mint, to be examined and reported upon.

The finish and conformity of coins to Standard further checked by sending specimens to England.

42. In regard to the method of checking the current expenditure, it will perhaps be desirable that we should go a little more into detail, with the view to the suggestion of a clear and satisfactory system; because the responsibility of the Mint Master as to the economy of the current expenditure, while it is by far the most difficult to test by comparison with certain criteria, is at the same time one, which requires the most

Current expenses difficult to check.

rigid scrutiny, and the largest freedom. We mean, that whilst the final *results*, ought in our opinion to be most strictly tested, the details ought to be wholly confided to the executive Officer. It is, however, a matter of considerable difficulty to devise a system by which the results can be clearly exhibited, and tested in comparison with others; on account of the variety of circumstances under which the work is executed, and the expenses incurred; but we think that a plan may be arranged, which if systematically followed, and made matter of record, would fully effect the object required.

Require strict attention as to the results and freedom in details.

43. We may here observe, however, that the proper method to check the accounts of a Mint, is not that of requiring the submission of a vast variety of details; on the contrary, we decidedly think that these multitudinous statements, so far from affording any real insight into the proceedings of the department, and thus laying them open for observation, tend to obscure the truth by their very multiplicity; and with reference to the principle which we advocate, that it is not respecting the details, but the general *results*, that it is requisite to satisfy the Government, we are of opinion, that while a distinct exhibition ought to be made of all the most important results only, all the voluminous items of detail ought to be struck out of the documents periodically submitted for inspection, although recorded in the books of the department, so as to be ready for production in case any inquiry should be made for them. By this method, we think, that the proceedings of the department would be much more clearly represented; and a mass of papers, which occasion much useless current expense in preparation and transcription, would be got rid of.

Multitudinous details of expenditure ought not to be submitted.

Trouble and Expense saved by simplifying accounts.

44. The difficulty in comparing the expenses of the establishment at different times, arising from the great variety in the work executed, may be obviated, we would suggest,

by adopting the principle of calling upon the Mint Master, at the close of each annual, or other periodical settlement, to assess the gross amount of his expenses upon the *whole* of the coins fabricated, according to the best of his judgment; and in the course of a very short period of experience, a scale of the expenses of fabricating each description of coin would thus be formed, by which all future assessments of the like kind could be judged; and a decisive opinion formed as to the economy and skill with which the business of the department had been conducted during the period under review.

Method of testing Mint expenditure.

45. We have seen the accounts of a Mint made up for submission to Government in such a manner, that the expenses were contrasted merely with the seignorage received from the Merchants, and other profits, and a balance drawn to show that there had been a clear gain to the State by the operations of the establishment; no notice being taken, in this account, of the silver or gold money coined on behalf of the Government, because no seignorage was chargeable upon them; and no further notice taken of the copper pieces, than an entry taking credit for the difference between the nominal value of the current money and the invoice price of the copper, which was added to the above mentioned balance, as a further gain to the State. But, however useful and satisfactory such a statement may be for the separate information of the Officers of Finance; we think, that for the purposes of the check which it is necessary to maintain over the expenditure of so large an establishment as the Mint, a different system, viz. one similar to that above suggested, would be much preferable; the object, as we conceive, being to show, not whether the business of the department has been carried on at a nett loss or gain to the Government, which is an indifferent matter, quite distinct from the responsibility of the Officers in charge of it, and one which may be influenced by accidental circumstances; but, whether

No check is obtained by contrasting the expenses of a Mint with the "seignorage" and other gains.

Expenses ought to be contrasted with work done.

the work actually executed during the period under scrutiny has been performed with as much economy as it ought to have been; in order to exhibit which, it is clearly necessary, that a contrast should be made, between the whole of the work performed, and the whole outlay incurred.

Illustration of the method of making this contrast.

46. By way of affording an illustration of the method we have above alluded to, we will suppose that the expenses of a Mint, during the period to be inquired into, have amounted to 100,000 Rupees, and that the work executed during the same time has been as follows. Of silver coins—Single rupee pieces, eighty lacs. Half rupees, 30 lacs. Quarter rupees, 40 lacs. Of copper coins—Half anna pieces, 15 lacs. Quarter annas, 20 lacs. One twelfth annas, 10 lacs. The following is the kind of assessment to which we have referred.

Statement showing the value of the work performed, in the fabrication of the undermentioned silver and copper coins.

Assessment of the work done.

	Rupees
SILVER COINS.	
80 lacs of single Rupees, at $\frac{3}{4}$ per cent upon the value,	60,000
30 do. of $\frac{1}{2}$ Rupees, at 1 per cent do. -	15,000
40 do. of $\frac{1}{4}$ Rupees, at $1\frac{1}{2}$ do. do. -	15,000
COPPER COINS.	
15 lacs of $\frac{1}{2}$ Annas, at 450 Rupees per lac, - -	6,750
20 do. of $\frac{1}{4}$ do. at 350 Rupees do. - -	7,000
10 do. of $\frac{1}{12}$ do. at 250 Rupees do. - -	2,500
Total	106,250

Table of rates to be formed by the assessments and used to check future expenses.

47. By this assessment it appears, that, supposing the rates of charge on all the pieces to be reasonable and customary, as judged by comparison with the former experience of the Mint, the amount in value of the work done during the period under review, somewhat exceeded the actual outlay which had been incurred; it might therefore be safely conclud-

ed, that the department had been managed with as much economy as usual.

48. A few years' experience, as we have already observed, would be sufficient, if these assessments were regularly made and recorded, to form a standard table of rates, at which the cost of the fabrication of all coins ought to be assessed at each particular Mint, under ordinary circumstances; and at which rates the work ought to be performed, unless some reason can be assigned for a variation; and this being done, it is evident that the check would be complete and satisfactory.

Assessments of one Mint cannot be applied to another.

Tables formed by assessments only to be rigidly applied under similar circumstances.

49. It must, however, not be forgotten, that the experience of one Mint cannot be applied to another in this way; because in every manufactory, but especially in a Mint, where so large a part of the highly paid servants, viz. those forming the custodial establishment, is equally as necessary with a small, as with a large business, the economy of the work is essentially dependent upon its total quantity: a fact which must also be borne in mind, in comparing even the results of the same Mint at different times; if the circumstances in respect to the number and value of the pieces fabricated, should happen to have been materially different from one another, at the two periods compared together; and especially if, at either of them, the establishment has not had *full* employment.

50. Having, however, thus secured an efficient means of check upon the *results* of all the outlays in the Executive Department, we think we cannot too forcibly insist upon the necessity of committing all the details thereof, to the unfettered management of the Head of the establishment. We advocate the strictest scrutiny as to the final issue of all the transactions of this large and important business, but we, at the same time, deprecate the unwise habit of inter-

The *results* of management ought to be checked, not the details.

ference in details, which although founded upon a real desire to protect the public interests, owes its existence to an obscure apprehension of the true objects of responsibility and trust, and the right course to be pursued in checking them. It is wrong to suppose that any one can so well judge of the expediency of any particular outlay for the peculiar wants of a manufactory, as the person whose whole occupation is the management of it; and it is also certain, that if that person be made, as he ought to be, strictly responsible for the results of his management, no one has a greater right than he has to decide upon the propriety of each item. Yet we are aware, that though the Officer in charge of a Mint may be much fettered by restrictions imposed upon him, the real consequence may be the very opposite of that which is intended; for it is undeniable, that economy of management is not by any means necessarily brought about by mere reductions of outlay; and we have had proof in our own knowledge, that an injudicious attempt to reduce the costs of such highly refined and artificial labour, by the mere effect of a close parsimony, and reduction of individual items of expense, may so dry up the sources of intelligence, and skilful economy, as to be the cause of a very ruinous extravagance in the end.

Mere reduction of outlay does not necessarily lead to economy.

51. Besides this, there is another consideration which ought not to be omitted, and that is, that the Head of the Executive Department, is not only responsible for the economy of his work, and on that account entitled to an unshackled freedom in his control of the outlay, but he is also accountable for its beauty and excellency; so that it is an injustice to him that he should be so tied down by any artificial restraints, as to be compelled to submit to inferior and disreputable workmanship; which besides being a disgrace to a well-ordered establishment, is the opposite to true economy.

The Mint Master responsible for the beauty of the coins, and therefore entitled to freedom in outlay.

52. We have known rules defining the rates of pay for workmen of particular classes, and limiting the amount of purchases of contingent articles required for the use of the establishment within certain sums, without special reference to the Government, and such like; and upon these restrictions we may observe, that circumstances will occur sometimes which necessitate a rise in salaries, such for instance as the construction of a rail-road, which would instantly require an advance upon the pay of all the workmen employed, or they would quit the service. Individuals also, by remaining long in service, even in the same situations, become much more valuable from the general experience and ability they acquire; so that although still holding the same post, it would be a real injury to the Public service if they were not kept contented by occasional increase of salary. And in regard to any general regulations of Government it must be noticed, that there is a very great difference between the case of those applications for contingent articles of expense, furniture, &c. &c. merely submitted by departments to Government for sanction, with explanations of their necessity, for its judgment to decide upon; but for which, when once granted, they are never made accountable; and the requirements of a Mint, of materials which are *absolutely* necessary for the current performance of its duty, and the costs of which are charged against it, and included in the current outlay, for which the Head of the Establishment is held strictly responsible. For while, in the former case, restrictions may be indispensable, as parts of a valuable system of control in regard to departments subject to no other check; they are uncalled for in regard to a Mint, if the true and rightful checks upon it are kept in regular exercise; in which case, every outlay made by the Head of the Department, being strictly accounted for, may be looked upon in the light of purchases made with his own funds, and at his own discretion; and he may, therefore, be safely indulged in

The outlays for the necessary materials for a Mint differ from the contingent purchases of another Department.

Mint outlays are checked in the current expenditure.

that liberty so necessary to his complete acquittal of the various and heavy responsibilities laid upon him.

Liberty in another respect necessary to the Mint Master.

53. And there is another respect, in which it is even more necessary, than in regard to the expenditure, that full authority should be given to the Mint Master; but before we proceed to mention it, we will first draw attention to the highly arduous and difficult character of the duties which he has to perform. We believe that the general and crude impression, which all, who have not inquired into the subject, usually entertain regarding the business of a Mint is, that it is an establishment in which there is the greatest possible temptation to frauds, and danger of the loss of the precious metals, owing to the multiplicity of the processes to which they are subjected, and the extreme difficulty of guarding against peculation; and that, therefore, every possible strictness of restraint, and difficulty of concession, should be used as a precaution against loss in dealing with this establishment; for unhappily this wrong feeling is but too often the accompaniment of the vague impression of danger. The fact, however is, that to whatever degree such a feeling may prevail, it is uncalled for, and unjust, as respects the transactions between the Head of the Department and the Government, or its representatives.

General idea entertained respecting a Mint.

Mistaken impression as to the general strictness necessary in Mint transactions.

54. It is true, that the greatest vigilance and most constant watchfulness are necessary for the preservation of the bullion; but all the risk is at the expense of the Mint Master; for if he be properly checked in the exercise of his responsibility; to which he is tied down in the simplest and most perfect manner, by mere attention to his receipts and deliveries, he is utterly unable to escape from the smallest atom of it, and bears the whole anxiety and care of his most arduous trust. The sole difficulty between him and the Government is, that both as to receipt and issue, *he* as well as

others, should be *fully* satisfied as to the truth and exactness of the debits and credits; that secured, he is firmly established in his charge, and bears the brunt of all the machinations and attempts at fraud which are daily, hourly, plotted against him; and singly has to fight the battles of the Government against the whole mob of thieves by whom he is surrounded.

The charge of a Mint in India a serious and difficult task.

55. Nor is it a slight responsibility which then attaches to him. He has to keep watch over an establishment employing perhaps three or four hundred individuals, taken from a class of the most crafty and dishonest men on the face of the earth; who, needy, and unprincipled, as they are, must unavoidably be trusted with silver or gold bullion to the value of many lacs of rupees, dispersed throughout the premises in every possible variety of form; solid and melted metal, bits, particles, filings, solutions, precipitates, drosses, and finished coins. He has throughout the whole course of manufacture, to guard against waste or dissipation, and the never-ending fruits of the apathy and negligence of many of his ignorant and careless subordinates; thus keeping an untiring watch over the innumerable openings which may be made for fraud or peculation. Difficult, however, as the task is, we do not think that success is altogether hopeless; but we are sure that to attain it, nothing but the strictest and most unceasing attention to a sound system, aided by full powers to carry it into effect, can be sufficient.

Only to be acquitted by unceasing care and strictness.

56. Preserving, therefore, the strictest attention to all those checks which secure the faithful acquittal of the Mint Master from his responsibilities, we think it cannot but be apparent, that to enable that Officer to perform his part successfully, and protect the interests of the Government, not only every confidence ought to be reposed in him, but every facility and liberal indulgence freely placed at his disposal. The particu-

Provided the checks be enforced, confidence and freedom in other things should be allowed to Mint Master.

lar point which we above alluded to, was the necessity, in the Indian Mints at least, for his having an *absolute* power over the whole of the servants under his command, as we are of opinion that it is a point of vital importance.

57. The Mint is not a common establishment. There are few public Offices which number so many as three or four hundred individuals; none, where out of so large a number, so great a proportion is taken out of the lowest class; and above all, where so many such characters are associated together, under exposure to such powerful and almost irresistible temptations, as every where must abound throughout a manufactory of the precious metals. And even in regard to common offices, every one practically acquainted with the character of the natives of India, must be aware how prone they are to trust for an escape from the consequences of misconduct, to the issue of an appeal to higher authority, and all the chicanery and intrigue which accompany their deceitful endeavours to influence those authorities in their favour.

Mint Master ought to have absolute power over his subordinates.

58. To keep the large establishment of servants attached to a Mint to a strict performance of their duties, and to stifle the intrigues and secret combinations for fraud which are so constantly apt to take root and spread beneath the smooth surface of their insidious profession, it is indispensably necessary that the firm persuasion should be rooted in the mind of every individual belonging to it, that the *only* way to secure his own advancement and promotion, is by obtaining the good opinion and favor of the head of his department, and that the failure to do so would be his certain ruin. While the Mint Master's conduct should prove, that the only way whereby any one could obtain his good will, would be the honest and faithful performance of his duty, and the neglect of it would be *certain* to be attended with disgrace and punishment.

Reasons for this power being entrusted to the Mint Master.

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59. If, instead of this, it be believed that the Mint Master has only a divided or partial authority, and that the consequences of his displeasure may be avoided by an appeal to other parties, however distant may be the hope of success, the charm would be at once dispelled; the chains which bound them to the strict performance of their duty would be snapped asunder, and the consequence would be, the perpetual recurrence of secret combinations against the head of the Department, and collusion for the purposes of fraud, in an endless variety of ways, which the artfulness and extreme cunning of the natives help them to contrive and execute, with but little risk of detection.

Danger of a want of full power.

60. With unfettered authority, the Mint Master may, by undeviating steadiness in his own pursuit of the public good, and the continual manifestation in his own conduct that such is his most earnest desire, impress the same character upon all the carefully chosen, responsible Officers of the establishment; and by their united exertions it is possible, we think, to cause even the inferior servants to perform their duties in a tolerably unexceptionable manner. Without it, it would be vain for him to attempt to draw the reins closely, and try to exact from a body of unprincipled men, whose eyes are turned in a variety of different directions for encouragement, that unity of purpose and zeal for the public service, which are essential to his own success in the fulfilment of his responsiblities; and without which, it would be as cruel and unreasonable, as it would be vain, to demand an exact acquittal therefrom.

The Mint Master with unfettered power may constrain his establishment and keep them to their duty.

61. Justice, moreover, requires that the acts of a Mint Master in the treatment of his servants should not be interfered with. The circumstances connected with the practical management of the establishment, and the course of work, involve such a variety of technical details, and generally, in cases of attempted frauds, are veiled in so much

obscurity, that when, as is usually the fact on such occasions, numbers are combined together in the common understanding to conceal the truth, it is a matter of the utmost difficulty, even for the Mint Master, although intimately acquainted with the characters of the individuals, and familiar with the nature and influence of every step of the manipulative processes, to arrive at a clear judgment as to the guilt of the parties implicated; and we have no hesitation in declaring, that it is absolutely impossible for any other person, destitute of these advantages, to avoid forming the most erroneous conclusions on such subjects.

Mint Master can alone decide questions of suspicion of subordinates.

62. That the Mint Master may decide wrongly in any particular case is very possible, but at the same time if, with all his advantages that Officer cannot decide rightly, it is absurd to expect that any other person, possessing only a fraction of his means of inquiry, should be able to correct him; and we, therefore, think it certain, that if it be probable the Mint Master is desirous to do right, and if he be competent for his situation, the strongest considerations connected with his power to restrain evil in his establishment, and protect the property of the Government, as well as the good of the subordinates themselves, require that his judgments, in all cases of suspicion of their conduct, should be *final;* and that his influence should on no account be ruined by the fatal persuasion of the *possibility* of his being interfered with.

On that account they should be left with him.

63. Finally, in regard to all the inferior servants, the Mint Master himself ought to exercise so little power, that the idea of interference "ab extra" must be seen to be out of the question. His exclusive and undivided influence is limited to the selection of the heads of the different departments under him; for it would be impossible to force upon their confidence, as highly responsible Officers, individuals whom they felt they could not trust. And in the same way, equally, in regard to himself, it would be highly dangerous to force

The power of the Mint Master in appointing servants necessarily but very small.

upon his confidence those Officers to whom he is obliged to delegate the important responsibilities he is charged with. The proper relation of power and responsibility seems to us to be, that the subordinate Officers should appoint, or at least concur* in the appointment and dismissal of, their inferiors; the Mint Master appoint and discharge his subordinate Officers, and the Government appoint and discharge the Mint Master.

Proper relations of power and responsibility.

64. The only exception to this principle which we are aware of, in which it seems to be possible that a case should arise such as to justify interference, is that of an Officer in only *temporary* charge of the department, who should through caprice, partiality, or hastiness of temper, be found to make extensive changes in the list of servants, the consequences of which would most probably be felt by his successor. In such an event, as the natural check inseparable from the use of the power of dismissal, and which would very quickly bring any permanent Head of the department to his senses, viz. that which immediately discloses itself in the impossibility of procuring the services of faithful and conscientious men, if the treatment they meet with be otherwise than just, would be wanting during a temporary incumbency, it might perhaps be desirable that an Officer, in *temporary* charge, should be liable to limitation in respect to the dismissal of subordinates, to such changes as could be shown to be imperatively called for.

Case excepted of an Officer in temporary charge of the Department.

He may be limited, if necessary, to unavoidable changes amongst the servants.

* It would not be safe to leave the appointment of inferior servants *solely* in the hands of the Subordinate Mint Officers; because they are not usually of a class who could be *altogether* depended upon as being free from any motives except desire for the Public good; and also, because a servant might be honest and most valuable in one department, and at the bottom of every fraud and mal-practice in the others. The Mint Master must, therefore, exercise an influence and veto in the selection of all servants, but it must be remembered that he bears *all* the responsibility. Whatever goes wrong whilst the bullion is under Mint custody, the Mint Master *alone* is responsible.

CHAPTER II.

On the valuation of bullion, and the processes connected therewith. Assaying of gold and silver. Assay Report—method of notation. Valuation of out-turn.

1. The valuation of bullion is calculated from its weight and fineness, which last indicates the proportion of *pure* metal in the whole mass of the compound. To make the calculation properly, the bullion must undergo the following processes:

First. The gross weight is taken.

Processes of valuation.

Secondly. The bullion is melted, and during fusion, thoroughly mixed, brought to a perfectly homogeneous condition, and poured into moulds of a suitable size. In silver, containing about 60 lbs.; in gold, about 15 lbs. each.

Weighing.

Thirdly. The bars thus obtained are, after cooling, thoroughly cleaned, and weighed. This gives the "net" weight.

Cutting "musters."

Fourthly. A couple of small pieces, called "musters," of clean metal, weighing about half an ounce each, are cut off from every bar, one from each end, and portions of them *assayed*. This process shows the proportion per cent of pure metal contained in the

"musters," whence is determined the value of the bar they belong to. The musters are cut from opposite ends of each bar, to guard against the risk of accidental imperfection in the melting, whereby the mass might not have been perfectly incorporated, and consequently be irregular in fineness, which would be shown by their differing in fineness from one another; when this is the case, the bar is re-melted.

Assaying.

2. There are two parties who are interested in the accuracy of every valuation of bullion delivered to a Mint; the Merchant who sells, and the Mint Officers who buy it; and it is absolutely essential to the satisfaction of the one and the security of the other, that both should have an opportunity of being perfectly convinced of the accuracy with which all of the above steps of the valuation have been conducted. This object is attained in regard to the first, second, and third, by their being conducted throughout, in the presence, and under the superintendence, of all the parties; who thus have an opportunity of seeing that their interests are strictly attended to.

Two parties to be satisfied.

3. In addition to this, it is desirable that in regard to the weighing, a further check should be established, viz. one which should secure the perfect accuracy of the weights used; as these, if not carefully attended to from time to time, are apt to become irregular and incorrect. The duty of watching over this particular ought to be vested in an Office independent of, and unconnected with the executive part of the establishment, and the responsibility seems to be one peculiarly suited to the office of the Assay Master.

Further check upon weighing desirable.

4. The most effectual and easy method of obtaining all the objects required is, that the Mint Master should be furnished by the Assay Master with, and should supply to the weighing man, whose duty it

How this may be done.

is to weigh the receipts and issues of the Mint (for it is only in respect to *them* that any check is required, or indeed would be proper) a *double* set of perfectly accurate weights, ordering him to keep one set aside, to be used solely for reference, and adjustment, and the other set for ordinary work; comparing them daily with the reserved set, and correcting them if necessary. With this provision, besides the necessary addition of an accurate pair of scales, the weigher is made responsible that the weights *actually used* in the receipts and delivery of bullion shall, at *all times*, whenever tested, be found correct.

The Assay Master should check the weighings.

5. The Officer, whose duty it is to exercise the check, may do so, either by taking an opportunity every now and then of coming unexpectedly to the scale, at the time that bullion or coins are being passed through it, and comparing the weights in use with others brought with him for the purpose; or, what would be far better, after any parcel of bullion or coins have been passed through the Mint scale, and recorded, he might unexpectedly call for part of them, and at his own scale, test the weighings of one or two bars or bags of coin, and thereby judge whether the correspondence be sufficiently close to indicate that the weights, scales, and manner of using them, be in all respects what they ought to be.

Do. do. do.

6. By this arrangement, the accuracy *at all times*, of the weights used in estimating the value, both of the receipts and the deliveries, may be maintained, with but little care or trouble to any person; and every security which it is necessary for the Government to provide in this respect, effectually accomplished: and it is to be observed, that although it seems to be a duty of the Government to see that the Merchants be not subject to any imposition or fraud in an establishment provided by them for Public use, and thus it is necessary that care be taken to ensure the most exact accuracy in estimating the

value of their bullion, yet the facilities for testing the accuracy of the weight assigned to it are so many, and so accessible to most of the Merchants, that the check now proposed is of less consequence than those which apply to the other processes of the valuation. It ought, nevertheless, to be constantly in force, in our opinion, in every well conducted Mint.

Melting should be *universal*.

7. In some establishments, melting is not universally applied to all bullion previous to receipt into the Mint; its use being partially dispensed with, in some cases, on account of the trouble and expense; and in others, because thought to be disagreeable to the Merchants. But we are decidedly of opinion, that neither of these reasons ought to weigh for an instant against a measure so indispensable to a strict system of check, and the security of the bullion, amidst the many dangers to which it is exposed.

Reasons.

8. The expense is by no means a matter of serious consideration, but if it were, we are of opinion that all the duties of a Mint, and especially the valuation of its bullion, ought to be efficiently done at *whatever* cost; and the more so, especially, as the charge levied from the Merchants as seignorage, more than covers the cost of the conversion of their bullion into coins, in the great majority of cases.

Objection of Merchants considered.

9. With respect to any objections which may be felt by the Merchants, to the introduction of this as a new custom, it appears to us out of the question that any one should plead for the continuance of an abuse so palpable. If they have been in the habit of receiving payment for coins, as bullion, in their gross state, thus being permitted to reckon dirt and grease as silver, at the expense of Government, and to the utter confusion of any thing like an exact check upon the value received from them, the sooner the practice is put a

stop to the better. No Merchant of respectability could surely wish to receive more than the true value of solid bullion actually delivered by him; and as to any others, it may be sufficient to observe, that none of them bring bullion as a favor to the Mint, but to serve their own interests; and therefore, if the Government performs its duty, by seeing that strict justice is done to all parties, nothing more is required.

Merchants objection inadmissable.

10. We are aware of several substitutes for melting, which have been recommended, and are in practice in some establishments; but we object to them all, as being not only mere approximations to that which ought to be done exactly, leaving a margin of uncertainty which interferes with the precise estimation of the bullion and consequent safety whilst under manipulation, but also as affording opportunities for fraud which it is of the utmost consequence to guard against, in this the most important crisis in its history.

Substitutes for melting are not allowable.

11. A question has at times been raised as to the size of the bars, and the weight of metal which ought to be taken upon one set of assays; but when the responsibilities connected with the receipt, custody, and produce of the bullion are clearly defined, and settled upon the proper parties, it would be improper, we think, to lay down rules, or to interfere with the free use of those means of security which they may think it necessary to adopt to ensure their acquittal. We may, however, venture to express it as our opinion, that the practice which obtains universally in the Royal Mint, where bars of the sizes mentioned above, (para 1,) are made use of, and each taken upon a double assay, seem to be most judicious and suitable to Indian Mints; though we should be inclined to make an exception in the case of the receipt of invoices of silver bullion exceeding 50,000 rupees in value, in which, we should think, the valuation of meltings of

Size of Bars.

10,000 rupees weight each, upon the average of three double assays from various parts, might be resorted to without any objection.

Mint debited by net weight.

12. It is only upon the second weighing, and after the value has been calculated and approved of, that the bullion is handed over to the Mint. Before that, it is the property of the Merchant, and secured upon his account, under his own seal. The net weight, after fusion, is that which is used in the calculation of value; the previous determination of the gross weight being merely necessary as a check against any fraud or accident in the melting.

Use of Assays.

13. The crude metal having been melted, and thereby transformed into a mass of a perfectly homogeneous quality; that is, an alloy composed of uniformly equal proportions of pure and base metal, throughout its whole texture; and having been likewise thoroughly cleaned from all extraneous and foreign matter, and its net weight ascertained, the only remaining step necessary to determine its value, is the discovery what the proportion of alloy is; or in other words, what ratio the pure silver bears to the base metal in the mass, and hence its standard value; and this is effected by the process of Assaying.

Nature of Assays.

14. Assaying is an easy kind of Chemical Analysis, which aims at the separation of merely one class of elements from the rest of the components of a mixed metal; namely, the precious, from the inferior; and the processes employed in it, are founded upon the property which the Royal metals, gold and silver, possess in a high degree, as compared with most others, of resisting combinations with oxygen and the acids, whereby they may be totally separated, and their quantity in any compound distinctly estimated. The assay of gold is effected by means of Nitric acid, and consists essentially of four processes,

viz. weighing, quartation, digestion, weighing. It is carried on as follows:—First. A certain fixed quantity of the specimen or "muster," and which is invariably the same in all trials (usually about 15 grs.) is very exactly weighed. Secondly. It is then alloyed by cupelling with it, very carefully, in the Assay furnace, a certain precise quantity of pure silver, usually about two and a half times its own weight. Thirdly. It is brought to the form and condition most suited to the full and free action of an acid, by being laminated, or flattened to a very thin sheet, and afterwards boiled or digested in strong Nitric acid, on a sand bath; and Fourthly. After being fully washed, dried, and annealed, to restore its metallic lustre, it is again weighed.

Assay of gold.

Details of the process.

15. The result of all these operations is, that as the cupellation removes all the inferior metals, and the silver also is not able to resist the oxidising and solvent power of strong Nitric acid, while gold is almost altogether unaffected by both processes, the whole of these metals which may have been united with the gold, besides the silver added in the second process, of quartation, are completely dissolved and separated, and the gold remains behind quite pure; and this, therefore, on being weighed, shows the exact quantity of pure gold which was contained in the unit taken for examination. Thus, if this unit or fixed portion of the "muster" operated upon be represented by 100, and the weight of the pure gold ascertained by the last step of the assay be 80, the conclusion arrived at from the whole assay would be, that the metal contained 80 per cent of pure gold.

Results of do.

16. The assay of silver is effected by the process of cupellation, which depends for its results upon the oxidising power of the air upon all the inferior metals, at a high temperature, and the solution and removal of the oxides, when associated with the

Assay of silver.

easily vitrifiable oxide of lead, by absorption into a porous vessel called a cupel. It consists essentially of three processes, two of which are weighing, and is conducted as follows:—First. A certain standard unit of quantity, which we may suppose, as before, to represent 100, is very exactly weighed. Secondly. It is then wrapped up in a small piece of pure lead foil, of a weight roughly proportioned to the supposed fineness of the metal, as judged by the colour, malleability, and general appearance, and being placed in a cupel, undergoes the process of cupellation, in a furnace constructed for the purpose. After which, the whole of the base metals having been removed by that operation, and the resulting globule or "button" of pure silver having been suffered to become cool, it is, Thirdly. Very exactly weighed, and the result shows the quntity of pure silver in the sample operated on. Thus, for instance, if the standard specimen, or unit taken for examination, be as above supposed 100, and the weight of the button by the same scale be 50, the conclusion arrived at from the whole assay would be, that the metal contained 50 per cent of pure silver.

Details of the process.

Result of the Assay.

17. The truth of this conclusion, when the assay has been skilfully made, is only so far questionable, that if there have been any other of the superior metals, such as gold, platinum, &c. &c. contained in the specimen, they would be included in the "button," and counted as silver; because as these metals have also the property of resisting the oxidising effect of the air at a high temperature, as well as silver, they cannot be separated from it by cupellation; and whenever any of them exist in any quantity worthy of notice, they must be estimated by some other process. In the ordinary business of a Mint, assaying by the cupel, which is almost exclusively used for silver, is only required in cases where the other superior metals are known, either not to be present at all, or in such small amount that they may be safely neglected,

Exceptions to the truth of the result.

and considered as silver, and as such allowed to enter into the composition of the standard coins.

18. In addition to the essential processes of the two methods of assay, as above enumerated, there are in regard to each, when conducted as a matter of routine, and applied to a perpetually recurring series of cases, a variety of subsidiary manipulations, which are useful in giving precision to the processes, and thus ensuring the uniformity and accuracy of the results obtained from them; and the whole business of assaying is thus reduced to the exact performance of a series of manipulations, to which every specimen of metal is uniformly subjected; and which, if attended to with *care*, are capable of leading to an uniformly accurate result in all cases, i. e. *to within certain limits of error*, against which no amount of skill or precaution can guard, as it arises from irregularity in the action of the depurating agents, which it has been hitherto found impossible to overcome.

There are other subordinate manipulations besides the three chief ones mentioned.

19. It is an important fact, that the assaying of either kind of metal is the conducting of the sample through a prescribed series of processes, which simply require to be closely attended to, according to prescribed rule, to secure all the accuracy which the art is capable of: because, it is one thing to invent and lay down a system, and another to follow it. It requires a person of the highest attainments in science, to do the one, it requires merely a person *of general intelligence, attention, and carefulness* to do the other: and it is the last, which it appears to us, is the duty of the Assayers at the Indian Mints; who, having been obliged to acquaint themselves with a certain system, we should presume, are intended to follow it. For want of definite instructions as to the nature, duties, and responsibilities, of these Officers, this is not clearly laid down, as we conceive

Assaying is an empirical art.

it ought to be;* because, although it is quite possible, that improvements may be made by the genius and skill of any assayer, upon even the best system at present known, and we would be far from wishing to throw the slightest obstacle in the way of any such improvement; still we consider it to be the duty of the Government, to guard the interests of the Public and the Merchants from the ill effects which they might be exposed to from capricious changes; and that, therefore, it ought to be a rule, that while the same system is followed in all Mints, and thus uniformity of result left contingent, solely upon the exercise of proper care and attention, all suggested changes therefrom should, previous to adoption, be subjected to full inquiry and investigation, and only made of universal application when *proved* to be of value.

Every Assay Master ought not to be suffered to introduce changes on his sole judgment.

20. A rule, such as the above, seems to be very necessary when the assays are taken upon the authority of the Assayer, without a distinct and efficient check; but is obviously of less importance, when the results are verified by an *external* check, and proved to be correct; in which case it is immaterial what changes may be made in the processes: but in any case, we think it desirable that a specification of the requisite system for obtaining a true assay should be laid down by authority, for the purpose of dissipating the needless obscurity in which the subject is veiled, of ensuring uniformity of method, and of effectually preventing the disputes which any discordance between the results of two different assayers might give rise to.†

Adherence to a prescribed process of assay not important when results are checked.

* If this subject were rightly understood, for instance, we think an Assay Master could not be permitted to state that he had adopted a "new mode of assay," without any notice being taken of it, which has been the case.

† The following remark, quoted from Ure's Dictionary of the Arts, (Art. Assay, p. 75,) on the subject of gold assays in England, seems to

21. As the assay of metal, about to be received into the Mint for coinage, is made for the information of the Merchants and the Officers of the Mint, to enable them to calculate the true value, and the price to be paid for it, it is necessary that information of the result should be communicated to them; and, for the sake of security and record, it is usual in the course of business, for the various samples examined in each day's work, to be distinguished from one another by numbers; their finenesses being stated in regular order in a formal document called the Assay Report, upon the authority of which the calculation of value is made.

Results of assays are recorded.

22. Stripped of all its technical mystery, the Assay report, in fact, merely expresses a "*vulgar fraction*," for the whole amount of the information derived from an ordinary assay, of either kind, is the ratio between the weight of the whole mass of the specimen of metal operated on, and that of the pure silver or gold contained in it. Indeed, every assay, of howsoever many subordinate processes, may be reduced merely to the three following essential ones, namely:—First. Weighing a certain portion of the compound. Second. Separating the base metals; and Third. Weighing the pure metal remaining. It is the result of this last weighing, divided by the first, which constitutes the fraction indicating the ratio of the pure metal in the mass; and it is this fraction which, in one way or another, is expressed in every assay report, and is the whole amount of information conveyed in it. We say the whole amount, because, although it might be possible to

Record of an assay is merely a vulgar fraction.

Every assay consists of three essential parts.

be much to the point, and applicable to silver in India, where that metal is the measure of value. "It is, therefore, indispensably necessary, that one uniform process should be followed in the assays of gold; and it is a matter of astonishment that such an accurate process should not have been prescribed by Government for assayers, in an operation of such great commercial importance, instead of every one being left to follow his own judgment."

guess something, as to the character of the alloys, by an intelligent examination of the residues, or the vessels and implements used in the process, no other real knowledge is attainable, unless new researches be made, extraneous to the proper assay; and while, on the one hand, guesses are inadmissable in the transaction of real business, so also the dependence to be placed upon the results of any extraneous researches, must be quite contingent upon the character and qualifications of the Officer who makes them.

The fraction indicating fineness is all the real knowledge derived from an assay.

23. Having arrived at the result, viz. for instance, the fact, that out of a muster unit of compound metal, weighing suppose 20 grs., 14 grs. consist of perfectly pure silver or gold, or in other words, that the proportion of pure metal is 70 per cent; the easiest method of recording this result, would doubtless be that which is here used, namely, the mere specification of the number of parts per cent; but the notation which is at present almost universally followed, is that which has been handed down by immemorial usage in England; and which, if not originally designed for that purpose, has at least the effect of wrapping up the matter in needless obscurity.

Easiest mode of recording the fraction indicating fineness.

24. According to this complicated system, two different forms of notation are used, one for silver, and another for gold. In regard to gold, the unit experimented upon is called a pound, and supposed to be divided into 24 parts, called "carats," and each carat into four subdivisions, called grains; and the fineness is denoted, by merely stating the number of carats, and grains, and parts of grains, which correspond with the weight of the pure metal, out of the unit or pound, which represents the specimen or muster assayed. The fraction, thus stated, is therefore one having the constant denominator of 24 carats or 96 carat grains, and as its numerator, the num-

Notation of gold by carats and grains.

ber of carats, grains, and parts, which show the proportion of pure metal in an assay pound of the compound. Thus an alloy of gold, containing 70 per cent of pure metal, would be expressed in direct terms, according to the carat scale, by saying, that it was of the fineness of 16 car. 3 grs. 2 tenths; that is $^{6}\frac{7}{96}{}^{2}$ths: another alloy, containing 50 per cent of pure gold, would be called 12 carats, i. e. $\frac{12}{24}$ths or $\frac{48}{96}$ths.

Example.

25. But the finenesses of alloys, or compound metals are rarely stated in direct terms; an additional complication having been almost universally employed by assayers, namely, that of stating the finenesses, not directly by the abstract proportions of the pure and base metal contained in them; but relatively, by the difference between the proportion of pure gold or silver in them, and that contained in the standard coins current in the country. According to this system, not only is there a different scale and method of notation used for each of the precious metals, but a different title, according to that scale, is assigned to the very same piece of alloyed gold or silver, in every new State or country; so that an alloy, which bears one title in one country, would bear a different one in a State adjoining it, in which a different mixture of metals was in use for the standard coin.

Mode of stating fineness of gold in relation to "Standard."

26. In India, the standard of the gold coins is $\frac{22}{24}$ths, or 22 carats; an alloy, therefore, containing 70 per cent of pure gold, or 16 car. 3.2 grs., actual fineness, as above, would be entitled as 5 car. 0.8 grs. "Worse" or inferior to "Standard." An alloy of 23 carats pure metal, out of the 24, or 95.83 per cent virgin gold, would be called, 1 car. 0 grs. "Better," or superior to "Standard."

Examples in relation to Indian Standard.

27. In silver, again, as we have above mentioned, a dif-

ferent Assay "pound" is assumed, and its divisions are consequently different, but the principle of the system of notation, is in other respects similar to the above. The unit or specimen operated on is here supposed to be divided into 240 parts, which are called pennyweights, as in the "Troy" pound; and the title or fineness of the alloy is declared by stating how many out of these 240 dwts. would be of *pure* silver. Thus an alloy of 70 per cent purity would, if its fineness were stated in direct terms, be called 168 dwts. fine; but in the language of Assayers in India, where the Standard of the coins is $\frac{11}{12}$ths or $\frac{220}{240}$ths it would be declared to be "Worse" 52 dwts. An alloy, containing 95 per cent of pure silver, or $\frac{228}{240}$ths would be called "Better" 8 dwts.

Notation of silver.

By pennyweights referred to "Standard."

28. We have entered into these details for the purpose of showing one of the causes of the great obscurity of Mint subjects, and of pointing out the natural and obvious remedy. It appears to us unwise and inexpedient, to wrap up and involve such a simple truth, as the fraction representing the ratio of pure metal in an alloy, in such a web of complication as that which now constitutes the usual assay notation; and were it possible to show what an incalculable amount of mischief and confusion it occasions, by the obstruction which it opposes to the ready and thorough comprehension of details by the Officers of Government, to whom it falls to discuss these matters, no further argument would be necessary to prove the great desirableness of the abolition of this antiquated system, and the adoption of a more simple one; an improvement which, like the making of good roads through a jungly and impassable country, it is in our opinion, on general principles, one of the first steps for an enlightened and intelligent Government to adopt.

Obscurity of these methods of notation.

29. Assayers in India, generally report the fineness of gold

to the $\frac{1}{4}$ grain, and of silver, to the $\frac{1}{2}$ dwt.; that is, to the $\frac{1}{384}$th part in the former, and the $\frac{1}{480}$th in the latter. The Assay "pound," is, therefore, practically subdivided by them into 384 and 480 parts, and their report of fineness states how many of these parts are absolutely pure. If the proportion of pure metal should fall any where between these subdivisions, no notice is taken, and no intermediate or more minute calculation is made; not on account of any difficulty, in reporting the trifling excess; for there can be no limit to the distinct expression of a *fraction*, however minute, by figures; but because it is found difficult, in ordinary cases, to ensure the accuracy of the process of assay, whereby the base metal is separated, to within much smaller limits of error, than the above named fractions. Some Assayers, however, do report to the $\frac{1}{8}$th carat grain, and the $\frac{1}{4}$th dwt.

Nature of the indeterminate fractions.

30. Were the Decimal system of notation adopted, as it would be easy, we think, to secure the accuracy of the reports to the $\frac{1}{500}$th part in both metals,* the finenesses might then be stated universally, in the proportion of parts per cent, and every fifth of intermediate fineness; that is, with the parts per cent as integers in the notation, and every alternate intervening decimal. Thus the Indian "Standard" fineness would be 91.666, &c.; the degree next superior, nearly corresponding to Br. $\frac{1}{2}$ dwt. would be 91.8. Br. 1 dwt. 92.0 per cent, the next higher in fineness being 92.2—92.4, 92.6, and so on; the gradations by fifths per cent being rather more minute than the old notation by half pennyweights.

Decimal notation would be somewhat more exact.

* We have, in a Memorandum, given in the Appendix, suggested the propriety of the Assays being reported to the $\frac{1}{1000}$th part, that is, with twice the minuteness here recommended; but that suggestion referred to the assay of metal for coinage only, which is a matter exclusively of internal economy. As the art of assaying now stands, it might not perhaps be expedient to report the public assays, used for the valuation of Merchant's bullion, much more minutely than at present; or than is above proposed.

31. As we have above explained, the title "Standard," as applied to an alloy of silver in India, means that $\frac{11}{12}$ths of it, or $\frac{220}{240}$ths is pure. Br. $\frac{1}{2}$ dwt. means that $\frac{220}{240}$ths is pure; Br. 1 dwt. that $\frac{221}{240}$ths is pure, and so on. We have also stated, that any intermediate degrees of fineness are never attended to; but as it might be anticipated, it rarely happens, that the weight of the button of pure silver, which remains after the separation of the baser metals, falls *precisely* upon any one of the subdivisions. In almost all cases, it falls between two of them, and the universal rule followed by Assayers, all over the world is, that in such cases the subdivision selected for report, is that which is nearest *below* the actual weight of the button of pure silver; thus rating the metal at the title of fineness, which is *less* than its true value, by whatever fractional difference of weight the button of pure silver might have possessed, over and above the weight corresponding with the stated subdivision. On this account, the purchasers of bullion in all countries buy metal at a trifle less than its actual value; but as they sell it again at the same, it occasions neither gain nor loss to any parties, except the person who disposes of it from the mine, on the first occasion of its being assayed, and who receives a trifle less than the real worth, and the party who converts it into coin, who gains that trifle.

Intermediate fractions almost always exist.

Universal rule as to the benefit by unreported fractions.

32. As in India, this latter party is always the Government, it is worthy of inquiry what the amount in value of this trifling fractional gain really is, for although small, in regard to any single purchase, it is not unimportant when applied to the vast transactions of a large Mint. We have, therefore, annexed in the Appendix, the copy of a memorandum, which has already been quoted, wherein it is explained how the aggregate value of all these indeterminate fractions, in a very large series of assays, may be accurately estimated; and it

Government ought to derive benefit from unreported fractions.

is therein shown, that it amounts to nearly the $\frac{1}{1000}$th part of the whole value of the bullion transferred to the Mint. As the reasoning in detail, upon which this conclusion is founded, is there given, it is unnecessary to repeat it here; we shall, therefore, merely observe, that as the bullion transactions of all the Indian Mints amount annually to between three and four hundred lacs of rupees, that is, to between three and four millions of pounds sterling, the value of the fractional surplus, which ought to be realised in the aggregate, *over and above* the values debited in the Mint books, ought to be between thirty and forty thousand rupees, per annum.*

These ought to yield a net excess of from 30 to 40,000 Rs. per annum.

33. We hold it to be the duty of the Master of every Mint, to attend as carefully to the realisation of this surplus, as to that of the remainder of the bullion, which is entrusted to him, and charged in the accounts of the Mint; and this, not merely on account of its value thus saved to Government, though even this is not inconsiderable; but chiefly, on account of the paramount necessity which exists in the management of an establishment of such magnitude and responsibility, for the utmost care in removing every obscurity which may hang about its transactions, in the receipt and delivery of the precious metals, and thereby, as far as possible, extinguishing all possibility of frauds, to which there is otherwise so strong and ceaseless a temptation. But a great difficulty stands in the way of any thing like a strict watch over the bullion entrusted to the Mint, when the Mint Master is obliged to depend upon the reports of a separate department for that knowledge of the value of the metal entrusted to him, which it is absolutely indispensable to its safe custody, he should be in a situation to assure himself of by an agency

Importance of attending to these unreported fractions.

Bullion cannot be guarded when it is received on trust.

* It would, perhaps, be only safe to calculate upon an excess of about 12 As. per mille, in which case, the surplus would range from 20 to 30,000 Rs

and means within his own power. When the rule and acknowledged duty of the Assayer, in reporting bullion entrusted to the Mint, as above stated, is followed *invariably*, the precise value of the trust may be calculated with certainty and exactness, within very narrow limits; and when the Mint Master can *assure* himself, beyond doubt, that a correct calculation has been made, he is in a position to crush every attempt at fraud, by taking decided measures, unfettered by the painful apprehension that he may be committing wrong and injustice upon innocent parties.

Great mischief of changes in the rule of reporting bullion.

34. This necessary element of safety, is in some cases quite unattainable, when the Assayer is in a separate department; and we know that circumstances sometimes exist, of such a nature, that no pains which can be taken will ensure an *undeviating* regularity in regard to the simple habit above mentioned; even at the time that it is acknowledged and proposed to be the rule of action; so difficult is it at times, when the rule of duty, though known and recognised, is not prescribed by authority, and kept in mind by frequent repetition, to establish an unswerving adherence to it. We, therefore, are of opinion, that if it be meant that Officers of the Honorable Company's Mints, shall pay a strict attention to the custody and produce of the treasures which pass through their hands, it would be proper that the Assayers, who are employed in valuing it, should not only have the rule distinctly established and enjoined upon them, but that they should, upon entering office, take an oath, that every report shall be founded *exclusively* upon the *result* of the *actual assay*, and in strict uniform accordance with the established custom, uninfluenced by any other consideration whatever.

Strict regularity cannot be obtained sometimes.

Assayers should make oath on entering office.

35. We are very desirous to guard against misapprehension, as to our object in the proposal just made, and which

in all cases, especially where Mints are regulated by the assays furnished from a separate department, we consider to be indispensable to the safety of the servants of the executive department, if any strict watch over the bullion is to be maintained; because we are apprehensive, lest it should be thought, that our earnestness for an uniform adherence to the rule of reporting bullion, in favor of the purchaser, springs merely from a desire that an uniform advantage should be given to the Mint; whereby the department would have the power of exhibiting a surplus, over and above the value debited against it. This, however, is far from being the case. Our wish is, that *whatever* rule for reporting bullion be decided upon, that rule be followed with absolute uniformity; because then, and then only, can the Officers who receive and are responsible for it, calculate with certainty, in the large way, the exact amount of surplus or deficiency, which exists between the actual and registered receipts; and having that certainty, which is totally incompatible with a capricious or irregular habit in the Assayer, can put a stop to the pillage which otherwise takes its origin, and is nursed by the obscurity which attaches to the calculation of value.

The object of this is certainty.

36. It is a distinct question, whether assay reports should be framed upon the half pennyweight next above, or next below the true value, and one with which we care not to interfere; for though we have above stated, that every Mint, on the settlement of its accounts, ought to show a surplus, if the fractional benefit has been given uniformly in its favour, as it is professed to be in India; yet, we by no means assert, that it can *create* a surplus; and it is, therefore, evident, that if the bullion be uniformly *over*, instead of *under*-charged, the same strict watchfulness and attention, which would be accompanied by a surplus under the one system of reporting the assays, could not but be followed by a deficiency under the other; and as we have never thought that it would be

Not the creation of a surplus.

meritorious to deliver that surplus in the one case, so in the other, we should be satisfied that no blame could justly be attached on the appearance of a deficiency. We insist upon the strictest uniformity, because it is only then that the results can be calculated on with assurance, and made the basis of decided measures for the security of the bullion. A short continuance in a purposed departure from the rule, when it is supposed to be uniformly followed, is sufficient to throw a whole Mint into confusion; and we are sure, that there cannot be a more painful, or truly perplexing position for the Head of a Department to be placed in, than that of a Mint Master, when his duty calls upon him to search out the cause of a deficiency; and having, previously, had the fullest confidence in the strict integrity of his servants, he is debarred from any other satisfaction regarding the assays, than that general trust which he is bound officially to place in them. In nine cases out of ten, no result at all can be arrived at, and in such a helpless dilemma, it is not to be wondered at if he is obliged to renounce all such strict scrutiny, and content himself with the guardianship of the bullion in the general way.

Certainty as to valuation indispensable to the safety of the bullion.

37. It might seem to be almost an act of supererogation to require that Assayers should confine their reports exclusively to the bona fide results of their assays, did we not know that this is not only not always done, but that in regard to some cases, the propriety of doing it, has been disputed. It might, indeed, if it were not true, almost be thought incredible, that any Officer of the Assay Department, after he had made an assay, and determined the actual fineness of bullion about to be debited to the Mint, should seriously propose to state in his reports *another* fineness, dictated, not by the results of his assay, but by other considerations as to what, in his opinion, the fineness of the bullion *ought* to have been. The fact, however, that such things have not

Assayers do not always record the bona fide results of their assays.

Inaccurate reports are sometimes given to the Merchants.

only been proposed, but also have been, and are carried into practice, by Officers who have every desire to do their duty, proves that it is high time that that duty should be more clearly defined; and so important is it, to the strict guardianship of the treasure, and necessary to the safety of the parties entrusted with it, that an uniform and unvarying system of assay should be adhered to, that we would recommend, in addition to requiring an oath from every Assay Master, on entering office, of the purport above specified, that each written report of assay should also be subscribed by a note, certifying that it is founded *exclusively* on the results of the process, at the trade assay, as a means of preventing these important points being ever forgotten.

38. The valuation of the out-turn of a Mint, is a different thing, altogether, from that of its receipts, and is involved in the act of testing the fineness of the Standard coins; a duty which is, as it ought to be, an object of attention with all Governments; and it is properly a part of the essential duties of the Assay Master. We are of opinion, however, that in consequence of the examination of the finished coins by that Officer, being usually regarded more in the light of a test, and approval, than in the more important one of valuation, far too little exactness has been thought necessary in the execution of it; and that consequently, the system which now prevails in many Mints, both European and Indian, is capable of much improvement. According to the plan which we now refer to, the assay examination of the finished coins is considered merely as a solution of the question, whether they are sufficiently near to exactness to entitle them to be called "Standard" or not? but the limits of deviation not being laid down by authority, (though the extreme limits, or "remedies" are) are left to the discretion of the Assay Master, and the result of the assay in every case wherein the coins

Valuation of out-turn of a Mint.

Not usually done with sufficient precision.

are pronounced by him "Standard," is simply tantamount to the assurance of that Officer, that they are sufficiently near the mark in his judgment, to be admitted into circulation; so that for all the use in valuation, which his report could be, it would be equally as effectual, if it were expressed in the words, "may be passed," or any other such terms of indefinite approval.

39. Now, bearing in mind, that the Mint establishment is entrusted with a most highly responsible charge, and that its acquittal therefrom, if it be ever acquitted at all, entirely depends upon the report which is made of the out-turn, by an independent authority, we must say, that we think that such an indefinite and vague system is highly objectionable, and ought, as soon as possible, to be amended. When the transactions of a Mint, at an annual settlement, amount to a couple of crores of rupees, the broad margin of uncertainty, created by such a loose system of stating the fineness of the coins delivered by it, and thereby estimating their value (including in its obscurity, as it usually does, nearly seven rupees, out of every thousand,) occasions an uncertainty as to the truth of the valuation of the out-turn, of no less than 140,000 rupees; it being possible, that the real value might either exceed that assigned to it, by half that sum, or fall short of it by the same, in an extreme case. With such uncertainty as this, it is impossible to introduce or act upon any thing like a *strict* system of watchfulness over the custody and produce of the precious metal; and it cannot be wondered, that at the very time that a microscopic accuracy may be pursued with regard to the *weight* of metal under manipulation, which may be accounted for to the fraction of a rupee, thousands may, unconsciously, be lost sight of in the fineness.

Reasons for more exactness.

40. This is a defect, which may be easily rectified; indeed, fortunately, without occasioning any additional trouble

to the parties engaged in it. The only thing necessary to set matters right, is that, like as in regard to Merchants' bullion, so in regard to coins, the *real* fineness should be stated, to the nearest eighth carat grain in gold, and nearest half pennyweight in silver, according to some uniform, unvarying system; and that the *average* of all these reports should be applied to the whole bulk of the coins issued from the Mint; whereby the true value of the whole out-turn may be calculated with great precision.

How precision may be attained.

41. Before proceeding to explain how the average may be most easily calculated, it will be better that we should first speak of the manner in which the coins are tested as to weight; as this will form a useful introduction to the consideration of the principle on which the fineness ought also to be taken notice of. We believe that it rarely happens that in any Mint the same want of precision is allowed in regard to the weight of coins, as that which is above alluded to as to fineness. We doubt whether it is the practice anywhere, after examination, to pass the coins as "Standard" in regard to weight, as well as fineness. In the Madras Mint a much more exact system is followed; the individual pieces are examined by the pyx, and their weights recorded to the $\frac{1}{10}$th part of a grain, although the only object is to secure that they shall not transgress the limit of deviation allowed by law.

How the weight of the out-turn is tested.

Weight of coins not taken for granted, because reported "Standard."

42. Now, if there were no other plan, the weight of the whole out-turn *might* be ascertained, by applying the average of a large number of these individual results to the whole number of pieces; but the real weight is so much more easily obtained by actual trial, that this is unnecessary; and in this particular of the valuation, the department is called

The true weight of the mass of coins is taken.

upon to acquit itself according to truth, to the very fraction; the specified number of pieces contained in the out-turn, not being credited to it at their nominal worth, although they may all have been passed, as far within the limits constituting "Standard;" but a deduction from, or addition to the nominal value being made in the accounts, according to any difference between the actual and standard weight of the whole out-turn, which may be found to exist. This proceeding is obviously correct, and one which secures the truth, and exhibits a fair view of the precision of the Executive Department, and it is a similar system which we conceive should be adopted in regard to fineness.

Rationale of this mode of proceeding.

43. Though it is infinitely more important that perfection should, if possible, be arrived at, in the weight of individual coins, because any defect in that point is palpable, and may be taken advantage of, yet no assumption is ever made on behalf of the Mint that it is attained in any single pieces, by allowing them to be reported "Standard," at the discretion of the Assay Master; but the utmost efforts are made to bring them within the narrowest limits of deviation; and whilst they are minutely examined, to test the degree of success arrived at, the precise accuracy of the whole mass of the out-turn is secured—First. By taking away any benefit which might result from a deficiency, by only crediting the department with the *true* weight; and Secondly. Having ensured that there shall be no *object* to be gained by inaccuracy, further securing precision, by instituting the practice of causing the deficiencies of one remittance, to be made good by the excess of another, and vice versâ.

44. The same objects may be attained, by valuing the whole out-turn, in regard to *fineness*, at the average of all the coins actually assayed, and reported according to

The same principle proposed in regard to fineness.

the exact truth. By this means, all risk of fraud by debasement of the coinage, is extinguished; *for the department can derive no benefit from the use of alloy, if its deliveries are truly valued at their actual bonâ fide worth.* It may, therefore, be reasonably expected, that when there is no possibility of gain by deviation from the Standard, and no way in which the subordinates can abstract the precious metals, without a deficiency appearing at the settlement of accounts, we have the surest guarantee that circumstances permit us to hope for, that all parties will unite in the endeavour to keep as close to the "Standard" as possible.

45. And we may here observe, that very rigid exactness as to the fineness of individual coins, is by no means so desirable as many suppose. If there were even very considerable deviations from the truth in part of the coins, we conceive it would be of comparatively little importance, provided the *whole mass* of the currency were maintained strictly true to Standard. We think the *last* is the object to be aimed at, much more than the first; and this because deviations in the fineness of the coins, however great, within certain limits, cannot be detected nor taken advantage of by the public; and in respect of the effect upon foreign commerce, and the exchanges, it is the average fineness of the whole mass of the currency, which alone regulates their standard value. We cannot, therefore, sympathise with the feelings of those who speak of the minute adjustment of the fineness of individual pots of metal, as though it was an object of the utmost importance, and to be done with the most scrupulous precision; because we are satisfied, in the first place, that as a matter of routine, the attempt to hit the *precise* standard in fineness is vain, and must be fruitless, on account of the uncertainty of the process of assaying itself; and also, because we know that all that is requisite on this head, may be done with great ease, by attention to the

Exactness in *individual* pieces not important in fineness, as in weight.

ordinary course of manipulation; while the real object to be desired, is attained with almost absolute precision, by merely adopting the precaution of causing the deviations each way to compensate one another.

A larger remedy in fineness suggested.

46. We even think it worthy of consideration, whether it would not be better in the Indian Mints, to allow a somewhat larger limit of deviation in fineness, in individual coins, than what is now customary; both because we are convinced of the perfect harmlessness of such deviations, when they are compensated in the manner we propose, and also because they are inconsistent with the larger,* though less allowable remedies permitted in regard to weight. We have known the whole mass of a day's coinage, on more than one occasion condemned, and the expense of a re-manufacture incurred, on account of a deviation in fineness of $1\frac{1}{2}$ dwt. from the Standard, which is in other terms an error to the amount of the $\frac{1}{146}$th part; although errors in weight of $1\frac{1}{4}$ grains in rupee pieces, (an error of the $\frac{1}{144}$th part) from the same establishment, pass without notice. This we think is a mistake in system, which ought to be rectified, because when the allowance of a wider margin for deviation (or "remedy") is unattended by the smallest disadvantage, which we have shown to be the case, if the system of valuation be properly conducted, it is a hurtful and needless obstruction to the efficiency of the Executive Department, and a vain waste of money to insist upon exact precision; and in regard to the fineness of coins the more inexpedient, because, unlike the errors in weight, a mistake therein cannot be ascertained during the progress of the pieces through their manufacture, and, therefore, cannot be rectified; so that the first discovery which is

Reasons for increasing the remedy in fineness.

* In the Madras Mint, the remedy in weight is $1\frac{1}{2}$ grs. or the $\frac{1}{120}$th part. In fineness, it is only 1 dwt., or the $\frac{1}{220}$th, little more than one-half the former.

made, is that which demands the total re-manufacture, not only of the condemned piece, but of the whole day's out-turn associated with it. We would advocate the maintenance of the remedy in the weight of coins within the narrowest limits compatible with economy and convenience of manufacture, but we look upon a straitened remedy in fineness in single coins as hurtful and useless, when the whole out-turn is properly adjusted to Standard; and we would allow double the present latitude in it, if it were considered necessary; but the reader must be careful to mark the distinction between the "remedy" as applied to individual coins, and a remedy applicable to the whole mass of the currency; in the latter, we think *no remedy whatever* ought to be allowed; it is in regard to the former only we would grant a little more freedom.

Practice of Assayers in reporting "pyx" coins.

47. We believe the universal custom amongst Assay Masters at all Mints, in regard to denoting the fineness of coins, differs from that mentioned in para 31, as the rule in reporting Merchants' bullion, and that the practice is to *under*-rate all coins which are superior to "Standard," and to *over*-rate all below it, so as in fact to throw the benefit of the doubtful fractions, in all cases, on the side opposed to the condemnation of the pieces. This practice has the tendency of representing the coins to be somewhat more accurate than they really are; but as respects valuation, if the number of coins below "Standard" be about equal to those above it, as they should be if their manufacture has been properly attended to, the result of omitting fractions on both sides of "Standard" is to do away with any surplus of value beyond the account, similar to that which exists in the valuation of bullion on receipt. But on the other hand, it militates against the strictness of the valuation, by leaving a margin of uncertainty of the breadth of a full pennyweight, or about 4½ per mille, in silver; and although this would be of no consequence if it be assumed that the executive duties of the

Mint are honestly performed, and the number of pieces, above and below "Standard," are without artificial management equal, (for in that case it might be presumed the pieces above and below "Standard" *within* the ½ dwt. each way, would be equal also,) yet, as it would leave an opening, which might be taken advantage of, we think, it would be desirable, it should be amended; either First. By a closer system of report; for instance, to the $\frac{1}{1000}$th, whereby the uncertainty still adhering to this practice would be reduced to 2 per mille; or Secondly. By abandoning the fractions, and throwing them into the currency, under-rating the coins as well as the bullion; by which means the uncertainty would be got rid of; or Thirdly. By adopting the first suggestion, and the second also, by which the utmost perfection would be arrived at in the valuation, and one-half of the value of the fractions would be saved to the Government.

48. In the Madras Mint, the system of reporting coins at their actual fineness, as above proposed, has been long followed with success; and we think, that if the notation of assays be, as hitherto, by half pennyweights, its introduction would be a great improvement in any Mint, in lieu of the more indefinite practice we have above referred to. In taking the average, the easiest method is to set off the coins reported "Worse," against those reported "Better" than Standard, reckoning each coin which may be ½ dwt. better or worse, as one: those 1 dwt., better or worse, as two each; those at 1½ dwt. either way as three each, and so on. Having thus made a total of the coins reported each way, "Better," and "Worse," at the above values, a balance is made, by subtracting one from the other, and the remaining difference, divided by the whole number of assays, including those of the coins reported standard, shows the proportion of the whole out-turn which is in excess, above or below Standard; according as there may have been more pieces report-

Mode of striking an average of fineness of the whole out-turn.

ed "Better" or "Worse." A calculation is then made of the difference of Standard value of this excess of coins either way, and its amount added to or subtracted from the total Standard value of the out-turn.

49. Supposing the whole out-turn of a Mint, for instance, had been forty lacs of rupee pieces, and that there had been 500 coins from amongst them assayed, of which the reports were as follows:

Example.

Br. 1	Br. ½	Standard.	W. ½	W. 1
5	40	320	135	0

The valuation would be made thus—Reckoning each of the coins reported Br. 1 at two, and each of those Br. ½ at 1, the total on the "Better" side comes to 50. By the same process the total on the "Worse" side is 135. Difference 85. The proportion of the 40 lacs, therefore, which is in excess, or beyond the exact balance of fineness on the two sides, is 85 pieces in every 500, or $\frac{17}{100}$ths. Taking $\frac{17}{100}$ths, therefore, of the 40 lacs of pieces, or 6,80,000 rupees, and reckoning the difference between their worth, had they been full "Standard," and what they are worth only of the fineness of W. ½ dwt., we find it to be rupees 1,545–7–3¼, and subtracting this from the 40,00,000 rupees, the remaining true value of the whole delivery is rupees 39,98,454–8–8¾.

Do. do.

50. Again, supposing the out-turn of a Mint were 60,85,000 rupees, and of these 4,180 coins had been assayed, of which the reported results were as follows:

Example of taking the true value.

Br. 1	Br. ½	Standard.	W. ½	W. 1
15	467	3,465	209	24

Reckoning these as before, the sum of the coins at their respective finenesses, on the "Better" side, amounts to 497. The sum of those on the "Worse" side, is 257; leaving,

on subtraction, a difference on the side of "Betterness," of 240 out of the whole number of 4,180 assays. Taking, therefore, $\frac{240}{4180}$ths of the whole out-turn of 60,85,000 rupees, or rupees 3,49,377–15–10, and calculating the difference in value between this weight of metal at Br. $\frac{1}{2}$ and "Standard," it is found to be rupees 794–0–7, which added to the nominal Standard value, increases it to rupees 6,085,794–0–7, its real sterling worth.

In a similar manner, the average deviation in fineness of a whole out-turn, may be calculated with exactness, from a large series of assays. Thus, for instance, in the last example, it appears, that there is an average overplus of fineness in the whole mass of coins, represented by $\frac{240}{4180}$ths of them being of the fineness Br. $\frac{1}{2}$, while the rest are Standard. The effect is the same as if the whole mass of the coins be represented by an average deviation from Standard of $\frac{240}{4180}$ths of a $\frac{1}{2}$ dwt., or $\frac{6}{209}$ths of a dwt., or very nearly $\frac{1}{35}$th of a pennyweight.

51. According to the Decimal system of notation, the mere average of all the assays, multiplied by the gross weight of the out-turn, gives the weight of the pure silver contained in the pieces, one-eleventh added to which, shows the true Standard value. The notation might be safely made to the $\frac{1}{1000}$th part, in regard to coins, because as the whole series of assays are comprised in one calculation of value, any slight *accidental* errors, which would in a large series compensate one another, would be of comparatively little or no consequence; and, moreover, much greater accuracy is attainable in regard to coins, than assays in general. If this could be done, it would be a great assistance to the Executive Department; and would also, we think, conduce to a greater accuracy in the valuation of the out-turn.

Mode of taking the average with Decimal notation.

In the Royal Mint of Great Britain, the "pyx" is taken at certain intervals by a sworn jury of goldsmiths; and the practice pursued is that of melting together a certain number of

Method of valuing the out-turn at the Royal Mint.

coins into a bar, which is then assayed; and it is the proud boast of the establishment, that there is no case on record, in which it has ever been discovered, that there has been any deviation from the "Standard." This speaks well for the uniform integrity and skill of the Officers of the executive department; but at the same time, we think, that as the regulations and practice of so large and important an establishment ought not to be founded upon the supposition, that its most responsible posts will always be filled by gentlemen of as high honor and trust-worthiness as those who have been lately, or are at present engaged in them, it would be very desirable that the acquittal of the responsibilities of the Mint should be effected in a manner which should not admit of the smallest opening for abuse; a desideratum which, we think, is not altogether attained by the present system, as the following remarks will tend to show:

Reamrks on this system.

52. In so far as it is proper that a fair representation should be made of the entire issues of the Mint, and an exact *average* taken of the fineness of the whole currency, it is evident that the plan of selecting a number of pieces indiscriminately, and melting them together, is well calculated to bring about the object intended; but then, it ought to be borne in mind, that as the hundred or more pieces are thus taken as the representatives of the *entire mass* of coins, the accordance of the average of their finenesses with the Standard must be *exact*, or there will be a wide difference in *value* between the whole bulk of coins which are thus tested, and their nominal worth; a very minute fraction of difference, in the average fineness of the *whole* mass, affecting a large amount in value.

53. On this account it is, we think, inexpedient, that when the true average fineness has been so fairly represented,

as it is by the melted bar, it should be subjected to a test which is incapable of pronouncing decidedly upon even the most minute shades of deviation from the exact Standard; because, to whatever extent an uncertainty may prevail in the process which is applied, to that extent the Officers of the Mint have free scope for taking advantage by adulteration, with the certainty, that even when done systematically, within a certain limit, the coinage must be pronounced *full* Standard; the very fact of the means used to obtain a full and fair average, affording them a sure guarantee that that true average will be exactly represented; and if so, that the degradation of the coinage will *certainly* fall within the limits of that margin of obscurity which it is impossible should not be allowed to tell in favor of the establishment.

Objection stated.

54. Thus, for instance, a systematic allowance of the $\frac{1}{1000}$th part more alloy in the gold coinage than the law sanctions, would be sure to fall within the limits which would be pronounced exact Standard; even supposing the jury of goldsmiths felt themselves competent to speak decidedly in condemnation to the minuteness of the $\frac{1}{8}$ carat grain, which is the $\frac{1}{768}$th part. If their process were less exact, or only to the $\frac{1}{4}$ grain, double that allowance, of course, would escape observation. But even the smaller deviation from exact Standard, may be considered as not unworthy of notice, when we call to mind the fact, that at the average annual coinage of the Royal Mint, of $2\frac{1}{2}$ millions, the advantage gained by even that trifling adulteration, would be no less than £2,500 yearly, and in a single year of extraordinary work, it might reach the large sum of nine or ten thousand pounds.

Illustration of the defect.

55. When the average fineness of the deliveries of the establishment is to be ascertained, as a test of their value,

we think that it is highly desirable that it should be accomplished in such a manner that the *precise* shade of deviation may be shown, and that with certainty; and this may be done in the way we have above suggested, viz., by making a separate assay of a large number of pieces individually, and combining the results of these assays in one fraction, which would truly represent the precise amount of excess or deficiency from the Standard.

56. Believing as we do, that the Assay Master of a Mint ought to be an Officer of *check* exclusively, it would seem to be a natural arrangement, that the combined fraction resulting from numerous assays of the "pyx" coins, should be calculated from those which he is in the habit of making of all the coins issued from the establishment; and with this more rigid examination, the Master's Assayer and Melter might be left unfettered in the free use of alloy, provided they were made accountable that the average were on the whole invariably up to, or above, Standard, a result which by proper management it is possible to make sure of within narrow limits.* Indeed, it appears to us as a necessary arrangement for the due acquittal of the large trusts committed to the Mint, that the finenesses of the pieces should be narrowly watched by the proper Officer of check, who should state the exact quality of each individual piece, with the greatest precision of which he is capable; and that the Executive Department should be bound to keep the whole currency *fully* up to Standard, by being debited with all deficiencies, and credited with all excess of fineness; and like the moneyers, required to keep the account

New method of acquittal suggested.

* The average deviation in fineness of the whole of the coins issued from the Madras Mint, from 1841 to 1848, has been shown by the result of more than 6,000 assays, to have been rather less than $\frac{1}{50}$th part of a pennyweight above Standard; and we think a much closer approximation practicable, especially in large coinages.

clear, or make good the difference. This account, however, would not in any way interfere with the transactions with individual Merchants or importers, who would in all cases receive weight for weight of their bullion in coins reported "Standard," when within the prescribed remedies; the proposed improvement upon the present practice being, that by the plan suggested, a register should be strictly kept, showing the exact fineness of the whole mass of the currency issued, and its thorough integrity constantly maintained; in lieu of its being as at present only guaranteed, independently of the high honor and integrity of the Officers engaged in the manufacture, by the satisfaction of a test confessedly incapable of more than an approximate scrutiny.

Some rule required to regulate the number of "pyx" assays.

57. It is very desirable that some general rule should be laid down, as to the number of assays which ought to be made in proportion to the extent of a coinage. In consequence of the prevalence of that view of this examination of the finished coins, which we have before remarked upon, (para 38,) we think that the idea has been entertained, that as long as there is every reason to believe that the duties of the Mint are conducted as they ought to be, it is immaterial whether there be many or few "pyx" assays; and this indifference, and the want of a criterion whereby to fix a rule has, we conceive, been the cause of a diversity of practice in the various Indian Mints, and even in the same establishment at various times. If, however, we view the matter in a different light, and consider, that it is the real and only valuation which is ever made of the issues of the Mint, it will at once be evident, that as a matter of duty, this valuation ought to be as strictly made as the valuation of the same bullion on its receipt by the department. Taking this as our guide, we should be led to the conclusion, that as the receipt of bullion requires two assays for every bar

Proper number considered.

of 2,000 tolas* weight, so in the out-turn, there ought to be not less than one coin doubly assayed out of every two thousand. But in consideration of the circumstance that the whole of the assays of the out-turn enter into one calculation of value, it is probable that a smaller number might be found sufficient to procure perfect accuracy in the result; and we think, that if one coin be assayed out of every 2,500, it would be enough. This is the smallest proportion which we would recommend the "pyx" to be reduced to in small coinages, though at the same time, to save trouble, we would propose, that in all cases wherein the daily out-turn exceeded 50,000 pieces, twenty double assays should be of single coins, and the remainder melted together, in samples weighing not more than ten tolas for rupees and half rupees, and five tolas for smaller coins. The assays of these samples, however, should not be allowed to be used in the general calculation of value of the out-turn, unless, either the notation be to the $\frac{1}{1000}$th part, or a distinction be made between those reported "Standard," as to which are above or below it in fact, and an allowance made if they do not balance one another; unless, indeed, the second or third suggestion, contained in para 47, be acted upon, in which case no precaution is necessary.

Rule proposed.

Small coins.

58. Finally, on the subject of the valuation of the out-turn, we may observe, that it is indispensable that this valuation should take place *after* delivery. The reasons for this are so obvious, that it is needless to enlarge upon them; we shall, therefore, only say, that it is essential to the full and satisfactory acquittal of the Mint. Test examinations of the pieces may be required previous to delivery, on behalf of the Executive Department, both as a matter of security

Out-turn of a Mint should be examined *after* delivery.

* 62lbs. 6oz. Troy.

and precaution, and at other times, in cases of doubt or suspicion, and to prevent or detect fraud; but these are quite distinct from the "pyx" examination of the finished coins, which we think it is essentially necessary should be made after the department has finally got rid of them, or at least at the time that a formal and complete surrender is being made.

CHAPTER III.

On the responsibilities, as to the valuation, and produce of the bullion, and the fineness of the coins.

1. Nothing can be more important in regard to all the essential business of a Mint, than that there should be the clearest definition of the responsiblility attached to each duty, and a distinct check upon the performance of it. But great difficulty lies in the way of the extrication of some of the most important of these duties, from the entanglement wherein they are involved in one another; and of this, the responsibility attached to the valuation and custody of the bullion, seems to be an instance. The main difficulty lies in this, that as the assay is a vital part of the valuation, no Officer can be charged with the responsibility of valuation, who has not the means, either of making the assay, or of so thoroughly testing it, as to fully satisfy himself of its accuracy; and as there is but one assay office in the Indian Mints, it has been looked upon as an inevitable consequence, that the Assay Master, who has the control over it, can alone be responsible for the accuracy of valuation. This, however, is an error, which has been attended with fatal consequences; for the attempt to establish it as the fundamental basis of a scheme of

Clear definition of duties and responsibilities very important.

Basis of the existing systems erroneous.

management has, wherever it has been tried, imparted a character of unsoundness to the whole system.

2. The Assay Master of an Indian Mint may be *trusted* with, but cannot be *responsible* for the correct valuation of the bullion delivered to, and operated on by it; and it appears to us to be a mistake to suppose it to be possible. Real responsibility, we conceive, essentially involves the notions of a check, and an acquittal; so much so, that if we could imagine a duty, the nature of which was such, that there was no means of checking its correct performance, the responsibility attached to it would be, "rei naturâ," merely nominal. In such a case, the utmost that could be done, would be to confide the duty to the person concerned, who must be trusted when he cannot be made responsible. It is in our opinion one thing to make an Officer responsible for the performance of a duty, by establishing a check over it, and requiring him to acquit himself of it, and quite a different thing to leave him without the possibility of check, and trust that he will perform his duty as he ought to do; but the last we call, not a responsibility, but a trust; and this is not the way, in our opinion, that any essential part of the important business of a Mint ought to be managed. Besides this, it is to be borne in mind, that a responsibility takes its origin from, and is based upon the possession of *power* to act. As it is unsafe and improper to entrust large powers without establishing a check, and insisting upon an acquittal, so it is foolish to demand the latter, without the previous delegation of the former. The first step towards the satisfactory performance of duties, is to grant adequate and *full* powers; the second, to establish an efficient check; and the third to insist upon an acquittal.

Nature of real responsibility.

3. We should not presume to enlarge upon truths so palpable and obvious, were it not that considerable misap-

prehension, and consequent difficulty are occasioned by the want of a clear perception of them, as regards Mint questions; and, plain as they are, they are not universally assented to, there being some, who, for want of sufficient precision in the meaning they attach to the term "responsible," frequently fail to draw the distinction between the moral obligation to perform a duty, and a *responsibility* as to the correct discharge of the same. Now, in regard to the valuation of bullion, there is only one way in which the truth and accuracy of its performance can be tested, and that is, by its *repetition*, by another and independent valuation, either while the bullion is unaltered, or after it has been alligated and converted into coins. In the last case, this would be by a comparison of the out-turn in coins from the Mint, with the valuation assigned to the metal on receipt. In either way, a separate series of assays, independent of the first. is necessary to check them; and in regard to the comparison of the out-turn value in Standard coins with the price of the metal, it must be observed, that this comparison can only be applied, in practice, to the *whole* of the bullion operated upon, and take place at the time of a clearance of the Mint, at the close of a long interval of work, during which the bullion must have run the gauntlet of all the peculations and frauds in every department of that large establishment. It cannot, therefore, be expected, that the Assay Master could be responsible for any deficiency shown by such a comparison, or *thus* acquit himself of his responsibility as to the value. In other words, the Assay Master can only be acquitted of his responsibility, in an unexceptionable way, by another distinct valuation, independent of his own, *before* the bullion is altered. If it be deferred till the bullion has gone through the Mint, his responsibility is necessarily mixed up and confounded with that as to its custody and manipulation.

The term "responsible" frequently misapplied.

The only check upon valuation its repetition.

Reason why the Assay Master cannot be responsible for the produce of bullion.

For this reason it is, we say, that it is impossible for the Assay Master of an Indian Mint, where there is no *second assayer*, to be *responsible* for the valuation of the bullion operated on by it.

4. Before going further into the difficult subject of the responsibilities connected with the Mint, it may be advisable that we should first take a somewhat nearer view of the duties of the establishment. Let us assume then, for the present, that the valuation of a certain quantity of bullion has been correctly made; it is to be observed, that in pursuance of the ordinary business of manufacture, it is the duty of some person to alligate, or mix and melt, the various bars together, according to their actual finenesses, in such proportions as may be best suited to the results aimed at; to watch the metal in its progress through the various stages of the coinage, to note the successive refinements and apparent wastages to which it is subject in the different manipulations, and to make such allowances for all of them, both on the first mixture of the bars, and on the subsequent remeltings of the particles, scraps, scissel, &c., as shall in the end cause the finished coins to be within the nearest possible proximity to the Standard prescribed by law; and consequently, with the least possible loss of the precious metal.

Duties of the Mint Officers in regard to bullion.

5. If these duties be correctly performed, all the bullion entrusted to the Mint may, as we have before stated, be restored without waste or deficiency, on comparison of the true value of its receipts and deliveries, the quantity contained in the drosses also being reckoned; but waste and losses may occur in many ways, if there be carelessness and mismanagement; and indeed cannot fail to be experienced if there be neglect, and the almost inevitable consequences of fraud and peculation in every part of the establishment.

Waste of bullion caused by carelessness and peculation.

6. Beyond all question, the greatest and most important of all the responsibilities connected with the Mint, is that which belongs to the safe custody and produce of the bullion, viz. that the value of the out-turn in coins shall be equal to that of the metal originally received; and the question now is, upon whom this responsibility can be laid, and how it can be checked and acquitted. Let us, with the view of answering this question, consider what the responsibility includes; or in other words, what duties need to be performed, in order to put it within the power of the person holding it, faithfully to acquit himself of the same.

The grand responsibility connected with a Mint, is the safe custody and produce of the bullion.

7. The precautions which it is essentially necessary that the Officer must take, who is thus accountable, are—First. To make sure that the whole value supposed to be delivered to him has been, bonâ fide, placed in his possession, at all events nothing *less*. Secondly. To take care that the proper quantity of the precious ingredients be put into the coinage issued, so as to cause them on issue to be precisely "Standard," and nothing *more;* and Thirdly. To watch and take measures against waste in all the processes of manipulation, and in the recovery of the drosses, &c. &c., or loss by peculation and embezzlement; thus carrying the bullion through the establishment, undiminished, to the final delivery.

Precautions necessary to be taken by the person responsible for custody and produce of bullion.

8. It must be noticed in passing, that the first and second precautions involve, and very properly, the checks for the security of interests immediately opposed to those of the Merchants and the public which it is the duty of the Government to protect; and hence, it appears to be an inconsistent arrangement to trust with the responsibility upheld by these checks, the Officer who is deputed to act on the part of the Government to protect the

public interests. Thus, besides the main responsibility as to the custody and produce of the bullion, which the Government, for its own sake, as the party who suffers by any waste, ought to see entrusted to the safe keeping of some Officer strictly accountable to them for it, there are also the other precautions mentioned in Chap. I., para 12, which it is incumbent on the Government, as its own duty, to take measures to secure on behalf of the Public, whose interests they are bound to provide for. We have just seen that the person charged with the custody and produce of the bullion, must necessarily see that nothing *less* than what is declared is delivered to him; it is the duty of the Government, on behalf of the Merchants, to satisfy them that nothing *more* is. In like manner, the Officer in charge of the bullion must see that the proper quantity of the precious metal is put into the coins, and nothing *more;* it is the duty of the Government, on behalf of the Public, to take measures to secure that nothing *less* is. Hence, we again see, that a separate and independent examination of both bullion and coins is requisite, and we think that this duty on the part of the Government, is the essential province of the Assay Master.

These precautions are checks upon those which the Government ought to take.

9. To return, however, to the question as to the main responsibility of the custody and produce of the bullion, we must remember what we have above pointed out, that no responsibility can exist except it be founded upon the possession of adequate power to perform all the duties necessary to the acquittal of it. Upon which of the Officers of a Mint, therefore, can the above most important responsibility be laid, according to the systems now in operation in the Indian Mints, or what is wanting to complete the efficiency of those systems? First. It is evident, that if the Mint Master has no means of

Neither Mint nor Assay Master can hold responsibility as to custody and produce of bullion, according to present arrangements.

performing assays, it is absolutely out of his power to undertake or acquit himself of it, on account of his inability to secure the first and second precautions mentioned in para 7; for, although the mixture of the metals and adjustment of the coins to Standard are within his power, test assays to prove the truth of the mixtures, and for the rejection of failures are necessary, which are not. And it is equally evident for the reason given in para 3, that the Assay Master cannot be responsible. There seems, therefore, to be good reason, â priori, to assume that a satisfactory arrangement, and distinct adjustment of the duties and responsibilities cannot be made according to the existing constitution of the Indian Mints; at least under the supposition that, as there is only one Assay Office, only one series of assays can be made:* but it will be necessary to inquire into the subject more minutely.

Present constitution of the Indian Mints precludes distinct separation of responsibilities.

10. It would appear from the regulations of some of the Indian Mints, that in consequence of the Assay Master having been looked upon as a perfectly unbiassed and disinterested person, in respect to both the Mint and the Merchants, it has been thought that the valuation of bullion tendered for coinage, if solely entrusted to him, must be satisfactory to all parties; but we think this is a mistake. In matters of business, in other things, it is never considered safe that affairs of importance should be entrusted to any person without an adequate and sufficient check; and the truth is, that as it is notorious that frauds and embezzlement are infinitely more easily practised in regard to bullion, through the agency of the Assay Office, than in the Mint, the valuation by an independent, and consequently unaccountable person, is not satisfactory to

Trusting the valuation of bullion to a third independent person, between Mint and Merchants, is not satisfactory to either.

We will separately examine the system of the Madras Mint, whereby this difficulty is obviated.

either party. The Merchants often feel themselves to be aggrieved, and indeed it is wonderful how much injury, real or supposed, they will submit to, rather than make a complaint and run the risk of offending; but the absence of a check is in such cases very far from being satisfactory.

Not to the Merchants.

11. In regard to the Mint, it is impossible that this arrangement could be assented to, if it be expected that the value committed to its charge should be returned without loss, and unless all deficiencies are permitted to be adjusted in the accounts under the head of "unavoidable waste in coinage." From the moment that this is put a stop to, and a really strict and faithful account is obliged to be given of every particle of precious metal entrusted to the Mint, it becomes impossible for the head of the department to take for granted all the debits made against him, by however respectable an Assay Master; and he is compelled personally to assure himself that the *true* value, and nothing more, has been fixed upon.

Quite inadmissible by the Mint, if its accounts are strictly exact.

12. We need not go far for an illustration of the truth of these remarks, which will be obvious when we merely refer to a fact which has been stated elsewhere, namely, that it was for many years the practice in the Madras Mint, for the Officer who valued the bullion delivered to it for coinage, in the shape of uncurrent coins belonging to the Government, to multiply the gross weight of the coins, including dirt, &c., by the fineness of a melted sample, and enter the whole, dirt and all, as solid bullion entrusted for coinage. Such inaccuracy could not exist if the Mint was made *really* responsible for its charge, and put under such checks that it should be obliged to acquit itself of the responsibility.

Instance in the Madras Mint of the danger of trusting a third person for valuation of bullion.

13. We may also cite a case which occurred in Bom-

bay, where there was a deficiency between the produce and valuation of a particular parcel of bullion received into the Mint, to the amount of about 1,200 rupees. A Committee being appointed to inquire into the deficiency stated, that the discrepancy was apparent, but as it would never do to doubt the assays, they must conclude the fraud had been practised by the melters. The head melter was accordingly ordered to pay the money, and did so; but it was afterwards plainly shown that the valuation had been made without proper precautions against mistake, and that in so far as the evidence went, there was not the least reason to believe that the quantity of bullion for which the melter had been held accountable had ever been received by him.

Instance in the Bombay Mint of the same.

Bombay case.

14. Moreover, we doubt not that the history of every Mint would furnish abundant proofs of the dangerous consequences of trusting the valuation of bullion to an indifferent person, as a matter of system. The danger is not merely the risk of error arising from carelessness or want of skill, the ill effects of which, if there be no check, are unrectified; but *sometimes*, even the results of an habitual omission of the necessary precautions to ensure accuracy. Occasionally too, owing to the absence of a proper system of check in the Assay Office, the influences of positive fraud, in collusion with the Merchants, are known to exist.

Assay Masters are not *always* sufficiently careful.

Their subordinates are not always honest.

15. We are aware, and indeed fully admit, that the *accidental* errors of a large series of assays, when a right system is regularly adhered to, may be put out of consideration, as far as the interests of the Mint or of the Government are concerned, as in the long run they might be reasonably expected to compensate one another; but it is

Accidental errors ought to be checked for the sake of the Merchants.

no satisfaction to the Merchant who suffers to-day by the under-valuation of his bullion, that another Merchant may to-morrow gain a compensation for his loss, and such would be but a poor excuse for not better protecting his interests. Moreover, there may be *systematic* inaccuracy, which would never be compensated.

There is also systematic error sometimes.

16. It may, however, be argued, that if the Assay Master be, as he ought to be, an honorable and upright man, competent to the performance of his duties, and attentive to the discharge of them, he will upon the whole do justice to all parties, and then that no difficulty need be apprehended. To which all that we need reply is, Suppose he is *not* so, or does *not* attend to his duties. What then is the result? The object of a system of check is, not to *trust* to honorable and upright men for the performance of their duties, but to guard against the consequences of a neglect of them; and it is altogether in reference to the efficiency of the system as a system of *check*, that we wish to examine it. But we must proceed to inquire into its operation upon the internal management of the Mint.

Reply to the objection that a competent and upright Assay Master ought to be trusted.

What is wanted is a system of *check*, not of trust.

17. If, on the occasion of a deficiency in the melting room, the Mint Master has not immediate and ready access to *proof* of the accuracy of the debits made against it, he cannot guard against the loss. Immediately after the receipt of the precious metal into the Mint, it is handed over to subordinates to undergo the processes of melting or refinement; and unless the Mint Master can satisfactorily prove the true value of their charge, he is helpless if it should be discovered that there is a deficiency in the out-turn.* For, if his subordinates be, as they ought to be, men in whom he has full confidence, and he is assured that every

Effect in the Mint of taking bullion on trust.

precaution has been scrupulously attended to, so that there can be no other cause for the apparent deficiency, than an erroneous estimate of the value in the first instance, it is quite impossible for him to bring home to their conviction any proof of their guilt or negligence, or to make them accountable; more especially if it be his experience, that in almost every instance in which the cause of such discrepancies has been previously ascertained, the truth has proved to be that the error has been in the assay.

Impossibility of tracing the source of a deficiency.

18. So situated, the Mint Master could not by any effort avoid, and consequently could not be responsible for loss; and he would naturally reply if called upon for explanation, to the effect, that the department had received a quantity of metal *said* to be of a certain value, that he had entrusted it to parties in whom he had the highest confidence, and that after every precaution had been taken, the result seemed to show that the value had been over-estimated. That it *might* be, that there had been fraud or embezzlement; or it *might* be that there had been an error in some of the many valuations or assays; but that between these two suppositions he was powerless to decide.

Position of the Mint Master in case of a deficiency.

19. Such is the position of the Mint Master on the occasion of a deficiency in the out-turn, at the close of a year's work; a deficiency which could not be traced to any person or department, when the duties of valuation, and the manipulation and custody are separated. The consequence is, that it must be impossible to demand a strict account and return of bullion in a Mint managed according to the plan of having the valuations made by an independent Officer, and losses seem to be almost inevitable.*

Difficulty of tracing the cause of deficiency when assays are made in a separate department.

* The losses in the Calcutta Mint, during the eight years extending

20. We have heard it argued, that the Mint Officers ought to be satisfied if, in case of a doubt arising as to the correctness of the assay of the bullion, an application were made by the Mint Master to the Assay Master to repeat his assay: the result of which second trial, as it would be performed with particular care, would no doubt be correct, and might be depended upon. But we are of opinion, after a practical trial of the suggestion, that circumstances will occur in which it will be found perfectly inefficient as a check against the discrepancies which are constantly met with, and absolutely incompatible with a rigid surrender of accounts, and a really responsible custody of the precious metals. Indeed, it evidently affords no remedy whatever for the grand evil of a deficiency in the general out-turn at the close of a settlement, as above mentioned; the elucidation of the cause of which would require the re-examination of all the assays of bullion made throughout the period of settlement. It could only be applicable to those minor cases of anomaly which are of daily occurrence, and which manifest themselves as they arise; and in regard to its application even to them, there is this practical objection, that they are so numerous, that if a personal application from the Mint to the Assay Master were necessary for the investigation of each, it is certain that not one in twenty would be satisfactorily disposed of.

Proposal that the Assay Master should check his own assays, considered.

It is not found to answer in practice.

It is inapplicable to general deficiencies, and impracticable as regards daily ones.

21. And, what is of more importance is the fact, that

from 1831 to 1838, both inclusive, as stated in the published account given in Rushton's tables, amount to rupees 432,011, being an average of 54,001 rupees per annum. The value coined during the same period was 1418,93,670 rupees; upon which, if we are correct in the opinion stated in Chap. II., para 32, as to the value of the benefit by the assay fractions, there ought to have been a gain amounting to very nearly, if not quite 141,893 rupees, or at the annual rate of 17,736 rupees, making the total annual waste equal to 71,736 rupees.

to establish a sound and secure system within the Mint, it is indispensable that the melter should be to the Mint Master, as the latter is to the Public and to the Government, *really* responsible, and that in a way which he himself could not dispute. To effect this, he must have access to the truth of *every* debit charged against him, so that on each occasion he can assure himself, if he pleases, of the actual receipt of the value he is accountable for. Without this, as it would be impossible for him at the close of a year's transactions to specify in which particular parcel of bullion an error had taken place, it would be impossible, without a re-examination of all the year's assays, as above mentioned, to demonstrate that the loss had not indeed occurred in the melting room; and to such an examination the melter would naturally and properly object, even if it were practicable, on account of the unfavourable influence of the bias against his character, and in favor of the former recorded assays, which could not but prevail in the Assay Master's mind. It is only by furnishing him with the means of checking every valuation as it is made, and thus making it his own fault if any mistake should remain unrectified, that the melter can be made really accountable.

To secure the Mint it is necessary that the melter should have proof of *every* debit.

22. This fact precludes the idea of appealing to the Assay Master himself for the verification of his own assays, besides which, the assays and their verifications done by the same person, as a matter of routine, would be in fact only tantamount to single assays more carefully made, and would themselves require verification. We may state also incidentally as bearing upon this subject, the fact, that experience shows that an unbiassed examination of disputed assays by the same person is hardly to be expected; and that, however indispensable check assays may be to the proper manage-

The Assay Master cannot check his own assays as a matter of routine.

Repeated requisitions for re-examination of assays, though absolute-

ly necessary, offensive to some Assay Masters.

ment of the business of the Mint, (and it is certain that very many such are really indispensable,) they are in some cases looked upon by the Assay Master with jealousy, as evidences of distrust, and tend to produce discussion and disagreement.

23. From what has been above said, it will be apparent that the system of causing the valuations to be made by an independent and indifferent person, cannot be looked upon as a system of *check*. It is plain, that the Mint Officers, according to such a system receive the precious metal on TRUST, and in dependence upon the assumed accuracy of the Assay Master's valuation; they are, therefore, entitled to expect that, in like manner, the produce of it shall be taken from them on *trust* also, if there be no apparent defalcation in its passage through any of the processes of manipulation. There is a further reason for this because, in the out-turn as well as in the receipt, the Officers of the Mint have no power whatever of acquainting themselves with the accuracy of the valuation of the metal taken *out* of the department in the coins, which are passed as "Standard," upon the sole judgment of the Assay Master, or of preventing a larger proportion of pure metal being put into them* than what is required by law, and the department is credited for; so that having no means of minutely testing either receipts or issues, it is utterly out of their

The system of valuation by an independent assayer is a system of *trust*.

Both as to receipts and out-turn.

* We have been informed, that in the year 1845, the coins issued by the Bombay Mint were so much above Standard, that if they may be assumed as being fairly represented by 50 pyx assays made of them at the Royal Mint, and the value of the out-turn calculated thereby, according to the method explained in Chap. II., paras 47 and 48, they must have contained very nearly 36,000 rupees worth more pure silver than they ought to have done; a case in point showing the impossibility of the Mint Officers guarding against loss, because if it be assumed that the Merchants were *fully* paid for their bullion, the Mint must have suffered the loss of the above sum.

power to guard against deficiency; and, what is still worse, on account of their uncertainty on these points, they are to a great extent helpless against the innumerable peculations from the large stock in their possession which do actually take place.

For want of precision and certainty, the Mint is open to depredation.

24. We do not mean, nevertheless, to assert that business may not be carried on according to this system, and even with some degree of apparent regularity; for it is not until *real* precision and exactness in the correspondence of the receipts and issues are demanded, that its deficiencies would force themselves into notice; it being very unlikely that the subordinates of an establishment so managed, even supposing them to be corrupt, would venture upon open robbery so as to attract notice, when the obscurities of the system were such as to make it easy for them to depredate large sums without observation.*

Business may be done on trust if exactness be not demanded.

25. We close our remarks upon this system by observing, that incomplete as it is in respect to the establishment of a check over the Mint, that is as to the secure custody of the property of Government confided to it; it is much more so as to the provision of that check for the security of the interests of the Merchants, which it is the sacred duty of the Government to maintain. While the duties of valuation and assaying are so arranged, affairs are in this dilemma; if we suppose the Assay Master to be the guardian of the responsibility of the *Mint*, in regard to the value of its receipts, we are left without a guardian of the interests of the Merchants; but if he be the latter, then we are at a loss for a protector of the Mint. Again, if we suppose him guardian of

Besides the absence of a check on the produce and out-turn, the Merchants have no check to guarantee their interests.

* In India, indeed, the mere fact of the business of a Mint being carried on in an uniformly quiet and unobtrusive manner, is (such are our agents) a suspicious circumstance, unless its duties be guarded by checks so clear and satisfactory, as to make evasion impracticable.

the establishment as to the quantity of silver put into the coins, we are met by the want of a representative of the Government to strictly scrutinise his performance of the duty; and, vice versâ, of an agent for the Mint. In short, the grand responsibility as to the valuation of the precious metal, subject to check by comparison with its produce, cannot be held by the Assay Master as a separate functionary, because of the essential interference of the whole of the Mint Officers and establishment in its manipulation and custody; neither can the corresponding *check*, on behalf of the Government, be maintained by him, on account of his own unavoidable entanglement and implication with the responsibilities of the Mint.

An independent Assay Master performing *executive* duties can neither act on behalf of the Mint nor of Government.

26. In the Calcutta Mint, we believe the Assay Master is considered responsible as to the fineness of the metal, and the Mint Officers are considered to be responsible as to its *weight* only; but this system does not in any respect essentially differ from that which we have above referred to, and it is subject to all the evils we have mentioned, with this addition, that the mere circumstance of relieving the executive department from all responsibility as to the fineness of the metal under manipulation, is certain to act as a strong encouragement and temptation to attempt adulteration of the mixtures for the purpose of abstraction, which no efforts of mere vigilance could possibly guard against.

In Calcutta Mint the Assay Master responsible for fineness, the Mint for weight of bullion.

This a worse system than the other, as encouraging frauds.

27. Under any system, the executive department, which has charge of the bullion during its manufacture into coins, must be entrusted with a certain gross weight of it; but it is impossible, we think, to establish an efficient check by reference to the weight only. In almost all the steps of the manipulation the metal

There must needs be precious metal entrust-

ed to the Mint, but it cannot be made over safely by weight alone.

undergoes changes in weight, which although tolerably uniform when all the circumstances and conditions of the processes are precisely regular, yet are governed by so many causes and hidden influences which tend to alter or modify them, that there is unavoidably an almost indefinite scope for artificial management of the results, and thereby for the practice of deception and fraud; which, in the absence of the evidence arising from the actual value of the metal really delivered, it would be impossible for any person unacquainted with the facts to detect.

The weight of the metal is continually changing.

28. Some of the influences here referred to tend to increase, others to diminish the apparent weight. Some are altogether extrinsic in their nature, and depend upon the addition or subtraction of foreign matter, such as dirt, oil, grease, oxygen, carbon, &c. &c., and in regard to these the effects of *all* the processes together, including the melting, ought to neutralise one another; so that, comparing the solid weight of clean metal originally melted, with the out-turn of finished coins, there ought to be no sensible difference. Other changes of weight are caused by destruction of the alloy, the effects of which ought to be carefully anticipated, and *compensation* made in the act of melting; so that the final result may be that the composition of the coins should be exactly what it would have been if there were no such thing as destruction of alloy, and the loss of weight neutralised by a previous addition of an equivalent of the base metal.

Variations in weight checked by attending to the undiminished integrity of the whole value

29. In attending to these points, the Mint Master acquires the power of checking the deliveries of the different departments of the Mint, and making allowances for the various changes of gross weight which unavoidably occur in the course of manufacture; but he could not do this if his judg-

at close of all the processes of coinage.

ment were not continually corrected by the exercise of the check afforded by the fundamental truth, that if all has been right, the value of the out-turn ought to be precisely equal to that of the metal originally received for coinage.* It is by close attention to the *whole* course of manipulation, and testing the results by comparison with unquestionable data as to the value of the receipts and issues of the establishment, that he is able to obtain positive information as to the occurrence of fraud or negligence in the manipulation; but when, as in the Bengal and Bombay systems, one-half of the executive functions is separated from the other, by the disunion of the melting responsibility as to fineness and value from the rest of the Mint, and the denial of power to the Mint Master himself to scrutinise the finenesses of the metals, and the value of his receipts and issues, even *he* is prevented from guarding against fraud and peculation in the apparent wastages, and if he is unable, it is of course vain for any other person to attempt it.

No check can be established by Mint Master when the melting-room is separated from the other departments, and he has no means of assay.

30. Under these circumstances, not only is he prevented from truly acquitting himself of a responsibility which he has not power to protect, except in the general way, that is as regards *gross* frauds, but the necessary means and facilities for searching out and preventing delinquencies being withheld from the only person capable of using them with effect, the upshot must be that they cannot be searched out at all.

31. The only sound basis upon which a secure and efficient check over the precious metal used in the manufacture of coins can be established is, in our opinion, the fundamental truth above referred to, that taking them *as*

* That is, exceeding the amount of the debit against the Mint by the "return of the assay," or value of the fractional excess.

The only sound basis of a system of check is the fact, that there is *no loss* in the *whole* coinage.

a whole, the processes of manufacture *effect no change* in the *value* of the metal. Hence it is only by giving charge of the whole to one Officer, with full power to perform all the requisite duties, that the business can be satisfactorily performed. The attempt, as we have before observed, to sever the parts of an integral and indivisible responsibility, necessarily involves its ruin, and the consequence of entrusting the *executive* assay duties to an Officer of a separate establishment, as in Calcutta and Bombay, in which Mints the Assay Masters, though improperly so called, merely perform the duties of Mint Assayers, and there is in reality *no* independent Assay Master, is not that of introducing any principle of supervision or check; but the threefold evil of—First. The annihilation of the *main* responsibility of the Mint. Secondly. The creation of an impediment to business, by the want of union arising from a disjointed establishment; and Thirdly. The abandonment of the most sacred obligation which it is the duty of the Government to fulfil, viz. the provision of an effectual check for the security of the interests of the Merchants.

The separation of the *executive* assay, from the other executive duties, ruins the system.

32. We have thus far spoken only of the responsibility as to the valuation, custody, and produce of bullion entrusted to a Mint, we now proceed to consider who is the proper Officer to bear the responsibility as to the accuracy with which the coins are adjusted to the true "Standard" in fineness; or as we may call it, the responsibility as to the fineness of the coins. In the Bengal and Bombay Mints, we believe, all the meltings for coinage are examined by the independent Assay Master, and passed for coinage if reported "Standard" by him, but if not, then dealt with according to his report. It must be noticed, that he alone judges whether they be sufficiently near to exactness or not,

Responsibility as to the fineness of the coins.

In Bengal and Bombay Mints the Assay Master is sole judge of the fineness.

and that it is entirely dependent upon his accuracy, and exclusively matter of his cognizance, whether the prevailing character, or average fineness of the whole mass of the out-turn be above, below, or exactly, "Standard;" and consequently, whether the quantity of pure metal really used be more, or less than, or exactly, what is credited to the establishment.

33. Now, in regard to the responsibilities connected with the adjustment of the fineness of the coins, we may observe, that there are two duties to be performed, viz. one to *make* the coins what they ought to be, and the other to test them on behalf of the Government and the Public, to ascertain that they are so. We do not think it a proper arrangement, that the same Officer who directs the alligations and adjusts the coins to the Standard, should be the authority to test them on the part of Government, and pronounce them correct; as is the case in Calcutta and Bombay: for this arrangement, even supposing that the Assay Master could be really responsible for the accuracy of the coins, would only be tantamount to leaving the executive Officer without any check whatever, which is obviously wrong. But the truth is, that the consequence of the division of the executive duties of the Mint between two independent departments is even worse than this; and although the Assay Master interferes so essentially in the business of the manufacture of the coins, as totally to shield every one else from blame, yet there is so much that is wanting in his powers, owing to his partial connection with the bullion, that even he could not be held unequivocally responsible for success; and it is made manifest when errors occur, and the pleas of the two separate departments in defence against blame are to be considered, that this arrangement of duties is not merely defective in consequence

There are two duties—First. To make the coins Standard. Secondly. To test them.

No local check in Calcutta and Bombay Mints.

Nor can there be even a distinct responsibility.

of the absence of a proper check upon a responsibility distinctly acknowledged; but that, just as we have shown with reference to the valuation and produce of the bullion, the confusion of the duties and powers of two separate authorities ruins the responsibility of both.

Arguments showing the Mint Officers cannot be responsible for error.

34. Thus, for instance, in case of the discovery of any serious error in the fineness of any of the coins passed into circulation, if an endeavour be made to trace it to its origin, the Officers of the Mint justly say that they cannot be answerable for the fineness of the pieces, because the metal for the coinage, as it is mixed in entire faith in the accuracy of the assay finenesses given to the different bars in the Assay Master's valuation, so after alligation, it is passed for coinage upon his sole authority, as he pronounces what he pleases "Standard." In fact, that the Mint Officers have no knowledge of any thing whatever respecting the fineness of metal, except as it comes from him; and therefore, if there be any error in respect to that point, it, necessarily can originate in no other source.

Arguments showing the Assay Master cannot be responsible for errors.

35. On the other hand, the Assay Master may say, and doubtless does so in all cases of blame, that although he is the sole judge as to the fineness of metal, still that he merely gives his report as to the fineness of certain bars or ingots taken from pots of metal examined by him, or on sundry stamped coins selected out of every day's work, and that in so far as those reports are concerned, he can vouch for their most strict accuracy; but that it is impossible for him to be answerable that a proper use has been made of the information conveyed in his reports, or that due care has been taken to prevent the variety of causes operating which might have occasioned the discrepancy complained of. Thus, that he had reported all the ingots examined by him "Standard" which were strictly within the

limits entitled to that appellation, and those which differed therefrom at their proper titles; but that he could not be by any means sure that proper precautions had always been used to prevent the confusion of the various ingots with one another, and the accidental substitution of those which might have been condemned, for those which were fit for coinage. Again, that in cases of defective manipulation in the melting department, it frequently happened that great irregularity existed in the different parts of the same pot of metal, and that though he might have examined one or two ingots out of a pot and pronounced them correct, other portions of the same pot, that is, other ingots, might have varied from them very considerably.

Arguments showing that the Assay Master is not unequivocally responsible for the fineness of the coins.

36. Further, he would say, that although he examined sundry pieces out of every day's coinage, he could by no means answer for the honesty of all the parties employed throughout all the different departments of the Mint, or undertake to say that those few selections fairly represented the average issues. For all he knew, advantage might be taken of him, and opportunities availed of to turn to use other metal than that approved by him, or even to introduce counterfeit pieces stamped in the Mint itself into the remittances from it, after he had selected his pyx specimens; and in short that nothing but the entire control and custody of all the metal manufactured into coins, from the very moment of its introduction into the melting pot to its final delivery to the State, could satisfy him sufficiently to induce him to acquiesce in a *real* responsibility for their individual correctness.

Other arguments to the same effect.

37. Thus we see, that in cases of misconduct, it is impossible to separate from one another the liabilities of two distinct departments en-

Impossibility of separating the two responsi-

bilities when the executive duty is divided between two distinct establishments.

gaged in one executive duty, and that the Assay Master, whose assistance if he were an independent Officer, would be most valuable to the Government in his proper office as a check, produces by his connection with the practical business of the Mint nothing but the ruin of that responsibility from which he ought to be wholly separate.

38. We are aware that it may be said, that it is not true that there is no check upon the Calcutta and Bombay Mints, as regards the fineness of their coins, for that specimens are selected from every remittance from the Mint, and sent to England, where they are submitted to the scrutiny of the Assay Master of the Royal Mint. This, however, does not constitute a check of the kind which we now refer to, or one which would be at all sufficient in our opinion. It cannot be looked upon as otherwise than a salutary precaution, that an occasional examination should be made into the way in which the Indian Mints, supposing them complete in themselves, execute the duties assigned to them; but the question now is, what is a complete provision for the performance of all the duties of a Mint, and whether it be proper or safe that the coinage taken from it should be issued to the Public without scrutiny? or in other words, whether the employment of an Officer, on the part of Government, to test the coins after their delivery by the executive department and *previous* to their issue to the Public, is not an indispensable requisite—an Officer perfectly free from all connection with the manufacture?

Objection that the coins are checked by the Assay Master of Royal Mint considered.

39. We decidedly think it is so; and therefore, as the report of the Royal Assay Master, though useful for the satisfaction of the Honorable Court of Directors is quite inapplicable to this purpose, since it is not usually received till years after the coins have been issued, we think,

we cannot be wrong in asserting that the occasional reference to the Royal Assay Master does in no respect meet the deficiency created by the absence of a local check; and as we have before seen in Chap. I. para 11, and Chap. III. paras 8 and 25, that the services of such an Officer are, independently, still more indispensable in testing the valuations assigned to bullion on its purchase by the Mint, we must conclude that the arrangements above referred to are defective, as well in respect to the responsibility regarding the fineness of the coins, as in that respecting the custody and produce of the metal.

Occasional reference to Royal Assay Master no substitute for a local check.

40. We may perhaps further elucidate the remarks contained in the few last pages by enumerating the five following objections which unite in condemnation of the system of trusting the valuation of the bullion received into a Mint to the Assay Master, and making him exclusively responsible for the fineness of the coins and the value of the metal operated on, and the Mint accountable for *weight* only. First. That the Merchants have no check to satisfy them that justice is done them in valuing their bullion, and no remedy beyond that of *trusting* the Assay Master to acknowledge his error if he makes one. Secondly. That by releasing the Mint servants from all responsibility as to fineness, there is a constant lure held out to them to debase the metal and commit theft. Thirdly. Because by withholding from the Mint Master the *proofs* of the exact value entrusted to him, his hands are effectually tied as to its preservation. Fourthly. Because by separating the weight from the fineness, the responsibility as to *value* cannot be held by any body. Not by the Mint Master, because he is never *satisfied* about it; and not by the Assay Master, because he cannot answer for the honesty of the whole Mint establishment. Fifthly. Because by implicating the Assay Master

Objections to the Assay Masters being made responsible for valuation of bullion and fineness of coins.

in a responsibility as to the value both of the receipts and deliveries of the Mint, it is impossible to appeal to any one as an *independent* umpire, to pronounce the full acquittal of its trust, in respect to the value of its coins, bullion, drosses, &c. &c. &c.

Correct system explained.

41. After all that we have said upon these points, it is almost superfluous that we should now enter into a detailed statement of what we consider to be the proper system of management, and adjustment of the two responsibilities to which we have confined our remarks; we will, therefore, very briefly express what we would wish to say on this subject.

Conditions of a satisfactory system.

42. The following appear to us to be the indispensable conditions to a satisfactory arrangement of this important business. First. The bullion ought to be valued by the Officers of the Mint, and the valuation checked on behalf of the Merchants and Government by an independent Officer, namely by the Assay Master. Secondly. It ought then to be subjected to all the processes of the coinage under the *sole* management and custody of the Mint Officers;* and Thirdly.

* We are aware, that in the Royal Mint of Great Britain the Assay Master interferes with the meltings, and regulates the addition of alloy; with the view, as it is said, of ensuring that the coins shall be brought within the closest possible degree of nearness to Standard; and they are afterwards passed upon his own report. But it appears to us clearly wrong in principle, that the Officer of check should be implicated in the performance of the very duties he has to keep watch over, and the more inexcusable in the British Mint where there is a Mint Assayer, who ought to be fully as competent to execute the duty which naturally belongs to his own office. Nor is the reason which is urged in favor of this practice, in our opinion, at all satisfactory. In the first place, as we have before stated, (Chap. II. para 45,) it is in vain to endeavour to hit *precise* Standard by the adjustment of individual meltings, on account of the uncertainty of the process of assay itself, and it is needless to attempt to do so, because success in individual meltings, even if it could be attained, would be of little advantage, the real object being so much more easily and exactly attained by the plan of

Having been by them manufactured into coins corresponding with the Standard required by law, and delivered to Government, should, *after delivery*, be examined by the Assay Master, and the true finenesses and weights of all the pyx specimens declared. The correspondence then, of the whole coinage with the Standard, as well as the closeness to it of the individual pieces would be made apparent; and the value of the entire out-turn would be calculated exactly, agreeably to the method pointed out (Chap. II. paras 48, 9, 50) and the Mint Officers would acquit themselves of their responsibilities. First, as to the fineness of the coins, by the fact of all the individual pieces being within the limits of deviation in weight and fineness prescribed by law, and the whole out-turn, "en masse," being precisely* Standard; and Secondly, as to the value of precious metal

Method of acquittal of the Mint Officers.

compensation upon the whole out-turn. Secondly. Even supposing the Assay Master's examination of the meltings were necessary, which we doubt, his interference in the adjustment of the coins is not; for when once the true value of the fraction representing fineness is ascertained with as much precision as can be depended upon, this can be made matter of record, and it is unquestionably as much in the power of any Officer attached to the Mint as it is in the Assay Master's, to regulate the melting by means of it. Having an Assayer attached to the Mint, there can be no good reason why the meltings should not be examined and the corrections made by *him*, the final examination of the finished coins being made by the Assay Master, subject to an occasional check by the Goldsmith's company, in like manner as the Assay Masters of the Indian Mints are subject to an occasional check by him. Whether there be any reasons connected with the peculiar constitution of the Royal Mint, and the contract system of executing the coinage, which may justify a proceeding there which would be so improper and inexpedient elsewhere, we are not able to say.

* We say *precisely* Standard, because if the executive department be credited with all excess of fineness, and debited with all deficiency, reckoning upon the whole mass of each successive out-turn, the result is the same as that of having no remedy; and the effect of causing compensation to be continually made must be, even supposing trifling fluctuations, that of keeping the average fineness at all times indefinitely near to absolute perfection

entrusted to them, by the correspondence of the value of their deliveries with the acknowledged value of the bullion handed over to them for coinage.

43. A doubt may be here entertained in the practical working of such a system, as to the disposal of those cases wherein a difference might arise between the Mint Assayer and the Assay Master. But we think that this difficulty would be obviated, if it were ruled that in all such cases a sample of the disputed assay should be sent for examination either to another Indian, or the Royal Mint. In the meantime the decision of the local Assay Master must be acted upon until the result of the reference be known, on the receipt of which all the expenses would be paid by the party who was in error. We think, however, that such cases would not be numerous, especially if the specification of an accurate process of assaying were, as we propose, laid down by Government, and in case of a disagreement of results, this were required to be followed jointly by the two Assayers in presence of a third person, previous to a reference.

Difficulty of a disagreement between two assayers obviated.

44. It must here be particularly observed, as regards the fineness of the coins, that the Officers of the Mint can only be responsible to produce a mixture of metals which corresponds with the "Standard," indicated to them by the *local* Assay Master, according to whose scale the metal is bought, the mixtures are made, and the finenesses of the coins adjusted. They know nothing of the *real* "Standard," and the Assay Master must be responsible that on examination in England, the coins which have been approved by him shall be equally approved by Royal Assay Master. The Mint is, therefore, acquitted of its responsibilities by the judgment of the local Assay Master, and the local Assay Master is acquitted by the

Assay Master responsible for the truth of the "Standard," and Mint Officers for the accuracy of the coins thereby.

result of the trials at the Royal Mint; and to avoid all risk of dispute, we think it would be most satisfactory if, instead of new coins, selections from the *remainders after assay* of all the samples by which the coinage of the Mint has been tested, should be sent to England, to be re-examined there.

Arrangement requisite for establishing correct system.

45. It only remains to be observed, that to place matters upon the above footing, it is absolutely necessary that the Officers of the Mint should be supplied with ample powers to compute the value of all the metal entrusted to them, including the assay, and to test the finenesses of the mixtures made of it, and such other trials as may be necessary from time to time in the course of business, to guard against malpractices within the establishment: and to effect this, it seems to us to be requisite, either that an Assayer should be attached to the Mint, for the separate performance of the Assay duties connected with the *executive* department, such as valuing bullion, managing the meltings, superintending the refinement and chemical separation of metals, and testing the fineness of the bullion in progress of manipulation, and coins *before* their delivery; or, that the system should be adopted which was formerly prescribed for the Madras Mint and carried on for many years, and which will be detailed in the next chapter.

Two methods stated to be practicable.

46. We are inclined to think, that the first of the above mentioned plans would be the best for a large Mint, and the second for a smaller one. The Madras system, as originally propounded being as we conceive unobjectionable, provided that the Officers who are to act under it are made acquainted with their duties, and *willingly* acquiesce in the performance of them. In regard to the appointment of a Mint Assayer, it may be worthy of notice that as an Assistant Assay Master is now usually appointed to each Indian

Mint, chiefly we believe with the object of providing an immediate successor to the office of Assay Master, in case of the unexpected or temporary incapacity of his superior, the expense of a new appointment would be avoided, and its objects would in great measure be obtained, by employing that Officer as a Mint Assayer, with the understanding that on those brief occasions when he should be required to act temporarily as Assay Master, there would be no objection to his performance of both duties. That is, in other words, that he should, during the interval, perform the same duties as are now performed by the Assay Masters of the Bengal and Bombay Mints.

Mode of obviating the additional expense of a Mint Assayer.

47. At the same time we think it a better principle, that no Mint Master should be without a Deputy, for which situation a well qualified Officer should be carefully selected, and instructed by the Assay Master in the proper method of making assays, which he might perform on behalf of the Mint, besides giving his assistance and thus becoming familiar with the general business of the executive department; and thus gradually acquiring a store of valuable experience sufficient to qualify him to hold its highly responsible trusts.

CHAPTER IV.

On the system of Mint Management followed at Madras since 1822.

1. In the last Chapter we have been led to consider the essential conditions requisite to the proper performance of the duties of a Mint, and the maintenance of the integrity of the responsibilities connected with them. Amongst these we have observed, that the chief ingredients are, First. In respect to the transfer or sale of bullion to the establishment, the satisfaction of both buyer and seller, as to the truth and exactness of the value assigned to the precious metal handed over; and Secondly. In regard to the issue of coins, the security of the Officers of the Mint, on account of their own responsibility, and the assurance of the Government, on behalf of the Public, that the proportion of pure metal put into the pieces is precisely neither more nor less than it is understood to be, and in accordance with what the law demands.

Conditions requisite for the proper management of Mint business.

2. We have also seen that the system of trusting to the unchecked valuations of an independent Assayer, which has been followed, as we believe, in all the Indian Mints except Madras, is deficient in both these conditions, First. In consequence of the total absence of any thing like *demonstrative* as-

Deficiencies of most Indian systems recapitulated.

surance as to the accuracy of the valuations of the bullion purchased by the Mint, for the satisfaction of either the Mint Officers or the Merchants; and Secondly. In consequence of the similar absence of any local check upon the accuracy of the coins, and the consequently total want of acquaintance of the Officer entrusted with the guardianship and custody of the treasure, as to the exact quantity of it which is withdrawn from his charge in the composition of them.

3. Now, the first of the above conditions is not by any means peculiar to the transactions of a Mint; but must, equally, if not more, be required in every case of transfer of bullion from one party to another; and hence, as we know that in the course of trade such transfers must be constantly occurring, it may naturally be expected that if we attentively examine the course of proceeding which is followed on these occasions in civilized countries, we may meet with a hint as to a method of surmounting the difficulties connected with it; and it will also appear that we shall be led thereby to a clear apprehension of the theory of the peculiar system of management which has prevailed in the Madras Mint for many years, and which it is our purpose now briefly to describe.

One of these conditions necessary for mercantile transfer of bullion.

4. We learn upon inquiry, that if a Merchant in any of the great cities of Europe, wishes to purchase a small quantity of bullion, which is offered to him by a party in whom he has no particular reason to trust, and the exact value of which he is altogether ignorant of, the proper course of proceeding would be as follows: The two parties would either appoint some person in whom they had both full confidence, or they would themselves superintend the melting of the bullion into a bar, from which a sample or samples would be cut off and despatched to

Inquiry into the commercial usage in the purchase and sale of bullion.

any one of the Assay Offices, of which there are three or four in every large city, with any distinguishing mark which might be agreed upon between them; and in the course of a few hours, a written certificate would be returned to them, stating the true fineness of the metal, by means of which, and the weight of the melted bar, measured in presence of both of them, the exact value would be easily determined.

Melting superintended or entrusted to a confidential agent.

5. Just as it would be necessary in regard to the melter, if that operation were entrusted to an indifferent person, that he should be one in whom both parties had perfect confidence, so, much more would this be requisite in regard to the Assayer, inasmuch as they cannot superintend, or scrutinise that operation themselves. They have, however, the advantage of being able to select from amongst two or three Assayers of established character, and also of knowing that none of these could have acquired or maintain their reputation undeservedly, since the truth and exactness of their work is capable of the easiest verification, by any person who has the smallest doubt of it; the only thing necessary, being to send repeated samples cut from the same bar of metal in the same spot, for repeated assays, under various designations, which any person has the option of doing as often as he may think proper, upon the mere payment of the trifling fee demanded for the trouble of performing the assay.

An Assay Office of established reputation applied to.

Method by which the reputation of an Assay Office is open to inquiry.

6. So firmly is the confidence of the Public established in the accuracy of the assay reports of the most respectable Assay Offices, that in all ordinary cases the fineness stated in the certificate would be, as a matter of course, assented to by both parties, in the case above cited, and it would be immediately made use of for the close of the transaction by the determination of the value and price to be paid; but

Remedy in case of doubt of the result of the assay.

let us suppose that it should so happen, that either the seller, from his knowledge of the origin and composition of the bullion, or the buyer from his observation of its appearance before or after melting, should hesitate as to the exactness of the assay, and feel dissatisfied with the result. In this case there is not the slightest obstacle to the parties sending a second sample, either with the same, or under any other designation, and obtaining a second report; but as we have just observed, this is but rarely done, from the firm conviction the parties always feel, that in nine cases out of ten, precisely the same certificate would be received. In event, however, of its being done, and a slightly different certificate being the consequence, it would then be obviously desirable that a third also should be obtained, in order to determine which of the shades of fineness, indicated by the two first certificates, was the most accurate representation of the composition of the metal.

A second or third sample submitted for report.

A third sample only necessary if the second should differ from the first.

7. We believe that the course of proceeding mentioned in para 4, is followed universally in all the principal cities and towns of Europe where Assay Offices are to be met with, and also that in any one of them, any number of samples may be sent under any designation whatever, and a correct report of the finenesses of them returned upon the mere payment of the ordinary fee. The most respectable Offices become established in the confidence of the trade by the tried and uniform correspondence of their certificates with the truth; (the only way in which *real* confidence ever can or ought to be established;) and the Assayers in thus rendering their services at all times available to the Public, present them with the valuable facility of obtaining the readiest possession of information of great practical necessity and usefulness, with the least possible trouble and expense.

Confidence in the Assay Office established by its tried accuracy.

8. By thus making use of an Assay Office, ever kept in close allegiance with the truth by the constant liability to the exposure of its errors, we see how easily two Merchants, both of them perfectly ignorant of every particular connected with the practical art of assaying, may, nevertheless, obtain perfectly satisfactory assurance as to the fairness and precision of the valuation of the metal bought and sold between them; because it is entirely within their power themselves to scrutinise every step essential to the valuation, excepting the assay; and in regard to it, they may have the most perfect satisfaction; for we must observe, that they have not only the power of testing the truth of any individual assay, by comparison of it with any number of other assays of the same metal done in the same office under different designations, but if these be not satisfactory, of appealing to any *other* office also; and it is deserving of particular notice, that it is this entire freedom of unlimited check, and perfect facility of exposure if the result be not in accordance with the truth, which on the one hand, keeps up in the Assayer that constant attention to the minute particulars of his art, which are indispensable to produce accuracy, but which from their wearisomeness might otherwise be disregarded; and on the other, by the influence which this has upon the accuracy of his practice keeps alive the confidence; which, based as it is upon the facility for the exposure of error, owes to that very circumstance the completeness of its satisfaction, even although the process of verification should, in ninety-nine cases out of the hundred, be never gone through.

Merchants ignorant of assaying can obtain satisfactory evidence of the fineness of their bullion.

Freedom of check the basis of the satisfaction.

The Assayer is kept attentive by his constant liability to check.

9. It is important to observe, that at the same time, and by one and the same process, any number of persons, besides the two immediate parties to the sale, who might be interest-

Any number of persons may be satisfied by one and the same process of valuation.

ed in the result of the valuation, might obtain the same assurance as to its accuracy as they do; a fact which is of some consequence as regards the application of such a system to a Mint, where many parties are implicated in the exactness of the valuation of bullion.

This is important in the business of a Mint.

10. Nor have we any reason to believe that the liability to the examination of their work, and detection of error is at all disagreeable to European Assayers, at least to such as feel they have acquired the confidence of the Public deservedly, and know that they can maintain it. We never hear of Assayers in Europe complaining of the repetition of samples from the same bar, or even hinting that they had any objection that their assays of the same metal under different designations should be set against one another for comparison, or contrasted with the results of any other Assayer; on the contrary, we believe that the practice of repeating samples is unusual, only because it is so well known to be perfectly superfluous; but that, were it otherwise, the accomplished Assayers who live by the art which they profess to understand and practise with accuracy, would not only be delighted, the larger the number of occasions on which they had the opportunity of vindicating their claim to Public confidence, but also be very careful lest they should undermine that confidence, by giving any expression to apprehensions which implied a diffidence in the result of its being put to the test.

Liability to check is not objectionable to the Assayers themselves.

11. The Madras system of Mint management is founded upon the above simple principle of making use of an independent Assay Office, *subject to check*, in lieu of a Mint Assayer, for all the purposes of the *Executive* Department; and the object of it is that of maintaining the responsibility of the Officers of the Mint in respect to the valuation of the bullion and coins, &c., com-

Madras system of Mint management.

Object of the Madras system.

plete, by enabling them personally to satisfy themselves as to the correct performance of every essential step of it, and to preserve the Assay Master exempt from any implication therein, in order that he may be left quite free for the unbiassed exercise of his functions as an Officer of *check* on the part of Government; in which capacity the whole of the finished work of the Mint is submitted for his examination and certificate before being passed into circulation.

Mint Officers are kept responsible.

Assay Master kept independent.

12. This system differs essentially from that of *trusting* to an independent Assay Master, not only by the fact that the stimulus of a constant liability to check tends to keep up the attention of the Assayer, and thus prevents errors, but also because, if there be unlimited freedom for inquiry, it affords the necessary satisfaction to the Mint Officers as to the value entrusted to them, which is indispensable to their responsibility; and it also protects the Merchants equally with the Mint Officers and Government. Moreover, it is superior to the plan of investing the Assayer with the responsibility as to the fineness of the metal, and the Mint with that as to weight only, inasmuch as, in addition to other arguments, besides obviating the impropriety of leaving the interests of the Merchants wholly unguarded, it invests the Mint Officers with a responsibility which they *can* acquit, and that to the very fraction; for the *value* of bullion is totally unchangeable by any process whatever, except abstraction; and a responsibility as to *value* once fairly established cannot possibly be evaded; but the responsibility as to the custody of a certain *weight* of bullion, which has to undergo all the processes of coinage *cannot possibly* be acquitted, as a loss of weight more or less cannot be avoided; and the delegation of this charge, therefore, involves the necessity of allowing a series of compensations for loss, which are the basis and origin of all the peculations and frauds to which the precious

metal is exposed. The following is the course of practice as it would be conducted according to the Madras scheme.

Details of the practice of the Madras system.

13. On the receipt of bullion, it is brought immediately to the Mint scale, and there weighed in the presence of the Mint Master and the importer. It is then lodged under the joint custody of the importer and one of the Mint Officers. As soon as possible afterwards the importer attends, and in his presence the bullion is removed, melted, and cast into bars, by him and the Mint servants together; immediately after which, it is again weighed in the Mint scale in the presence of an Officer of the Mint and the importer, the bars having been first cleared of any dirt or extraneous matter adhering to them.

Gross and net weighing of the bullion.

Bars stamped in presence of the owners.

14. Previous to the second weighing, the importer is called upon to witness the numbering of his bars, that is, the *stamping* upon them the Mint numbers by which they are distinguished from one another, and from other bullion; and when this is done, a small piece or muster, weighing usually ½ tola or 90 grains, is cut off each end of each bar, under the joint inspection of the Mint Master and the importer. In regard to every bar which is operated on in its turn, the pair of "musters" belonging to the two ends of it are, at the moment of being cut off, folded up in paper separately, then the packets joined together and included in a little parcel which is numbered with the Mint number of the bar they have been cut from. If there are many bars, all the parcels belonging to them are finally enclosed in one large packet, which is securely made up and sealed with the Mint Master's seal, and despatched in a box with a patent lock, of which the Mint

Musters cut in do.

Precautions used in sending for assay.

Master has one key and the Assay Master the other, to the Assay Office, the delivery into which the importer is at liberty to satisfy himself of, if he has any wish to do so.* After the process of Assay has been concluded, a report is transmitted to the Mint Master, under the signature of the Assay Master, stating the finenesses of the musters belonging to the several numbers marked on the parcels, and consequently showing the finenesses of the bars from which the musters were cut.

Assay report how obtained.

15. This is the course pursued if there be no apparent discrepancy between the two musters which belong to any one of the bars, sufficient to make it appear that the melting had been improperly done, and consequently that the bar is not homogeneous, or uniform in its quality as to fineness. If, however, there should be any considerable difference between the finenesses of the two musters, that is between the two opposite ends of the bar, so as to make it evident that the composition of the metal was irregular, no assay report would be given, as of the fineness of the whole bar, but the caution "to be re-melted," would be inserted in the space of the report opposite to the Mint number of the bar whose two musters thus disagreed, thereby showing that it was not in a sufficiently uniform or homogeneous state for a fair report of its fineness to be made. It would then be melted again, as before, and other musters sent in like manner, until a report of fineness had been received.

Irregular meltings not reported.

16. After the finenesses of all the bars have been ascertained, and agreed to by all parties, the importer takes a receipt, which is given him by the Mint Master, specify-

* A letter from the Mint Master also accompanies the parcel, specifying the Mint numbers of the musters transmitted for assay.

Mode in which payment for the bullion is obtained.

ing the net weight of the bars and their Mint numbers; and on the delivery of this at the Assay Office, he has it exchanged for another stating the "out-turn value," obtained by calculating the fineness, and deducting the seignorage and refining charge, if any, on presentation of which at the Government General Treasury, he is entitled, at the end of thirty days subsequent to his original tender of the bullion, to receive the amount.

Method of check in case of dissatisfaction with the assay.

17. In event of the assay report upon any one of the musters appearing, either to the Officers of the Mint or to the importer to differ from the expected fineness of the bullion, a second pair of musters is cut under the same precautions as before, and transmitted with the like care to the Assay Office, together with the other packets of the day, and to this duplicate packet a *new* number, differing from that which was attached to the packet containing the first or original numbers is now affixed, as it is now to be marked with the next current number which may fall to it in the regular order of transmission of the daily musters for assay. On the receipt of the report upon the second pair of musters, the fineness declared by it, is compared with that previously stated, and if it agree, no further doubt can be entertained as to the accuracy of both; if, however, it should differ, a third is sent, which decides the question.

Method of check in case the alligation gives a wrong result.

18. The same process of check is also observed by the Mint Officers, in case any bars whose assay might not have been objected to by the Merchants should, upon being melted together in alligation, produce a result different to anticipation. In that case "duplicates" or second musters which had been previously cut and set aside, of all the bars contained in the pot of alligated metal, are submitted in

the ordinary course of business, for a check assay, the result of which shows whether the deviation has been occasioned by error in the assay of any of the bars mixed together, or if it be attributable to some other cause.

Mode in which the Mint is debited for the bullion.

19. When the bars of Merchant's bullion have been valued as above described, they are debited against the Mint at the out-turn worth calculated by the Assay department, that is at the exact "*Standard*" value for which they were purchased previous to the deduction of the seignorage and refining charge. In the course of business they are transferred to the melting department, whose Superintendent has been a witness to all the proceedings of the valuation, at the same or "Standard" value, and the servants of this department combine or alligate the bars together according to directions given by the Mint Office; being expected, not only to return the metal of the precise "Standard" quality in respect to fineness, but also to deliver, weight for weight, the exact amount in value of Standard metal entrusted to them.

Responsible charge made over to the melters.

Mode in which an assay of "ingots" is obtained.

20. The ingots which are produced by the melting department are submitted for the inspection of the Mint Master, who cuts "musters," and folds them in separate parcels, just as with Merchant's bullion, and after affixing the Mint numbers, includes them in the same packet with the other musters of the day sent to the Assay Office for report; which report states their true composition to the nearest ½ dwt., according to which they are dealt with by the Mint Master: being passed for coinage if sufficiently near to "Standard," and if not, returned to the melting pot, to be either re-alligated, or otherwise brought to the correct fineness.

21. There is a check upon all the subordinate depart-

ments of the Mint on behalf of the Mint Master, which is effected by the Assay Master's taking specimens daily from one or other of the rooms, without notice, and after assay reporting the result to the Mint Master and the Mint Committee.* The final check, on the part of the *Government* is on the coins *after delivery* by the Mint; specimens of each day's coinage being selected by the Assay Master from every remittance made to the Government Treasury, and assayed, and a report made to the Mint Committee; who upon the receipt of the Assay Master's certificate of the coins being in all respects conformable to the regulations, authorize their being passed into general circulation. It is only *after* the receipt of this authority, that the Mint receives credit in its accounts for the amount in value of its deliveries.

Check upon the subordinate departments of the Mint.

Final check of the Mint on the part of Government.

22. The first observation which we would make upon this system is, that in so far as relates to the transactions between the Mint and the Merchants, the system of check seems to be complete and satisfactory. In the purchase of bullion, as

Observations on the Madras system.

We think that as regards right principle, and indeed practice also, this is not the truest course of proceeding, because the object of the check is entirely an internal one, and part of the internal agency whereby the Mint prepares for the ordeal to which its work is exposed after delivery. It is the Mint Master who has to guard against frauds whereby he may have reason to dread that the bullion may be debased and thereby perhaps made away with, and it ought to depend upon his vigilance to submit specimens of the coins, or if necessary, pieces of metal at various times for examination, just as he would do, were his establishment complete by including within it an Assayer. The rule and practice ought to be, therefore, that the Mint Master or his Deputy should from time to time select the coins or pieces of metal and send them for assay. If there be a *sufficient* examination of the whole of the deliveries of the Mint to give *undoubted* proof of the integrity of the coinage, the Government have no reason to inquire, and had far better not meddle with any matters that take place within the walls of the establishment.

in every other purchase, there are two opposing interests, the interest of the buyer and that of the seller; each party desiring to make as good a bargain as he can. It is, therefore, of great importance that both should be afforded the fullest opportunity of satisfying themselves as to the fairness and truth of the valuation upon which the purchase is founded. By the plan above described, whereby both the Mint Officers and the importers are parties to, and have a full insight into every successive step in the valuation, this object is effectually provided for. Both parties witness every step in the processes by which the valuation is effected; viz., First. Of weighing the bullion in the gross, on receipt. Secondly. Of melting and admixture, or reduction of the bar to a perfectly homogeneous condition; and Thirdly. The second weighing of the clean bar, for the determination of the net weight of solid metal actually delivered.

Means of check afforded to Mint Officers and Merchants.

23. The processes here described are usually attended to with minute exactness, all the scoriæ, drosses, every thing supposed to contain even the most inconsiderable portion of silver or gold, and the very smallest particles, being carefully collected together by the Merchant, who is permitted to take them with him out of the Mint, under the authority of a pass signed by the Mint Master; and the character of the operations above enumerated is so simple, that there is little risk of a fraud being perpetrated in the performance of them, without the wilful concurrence of the person who is to lose by it. Under such circumstances, we conceive, that no further guarantee for their being honestly and fairly conducted need be sought for, inasmuch as no check is likely to be so scrupulous, unrelaxing, and incessant, as that of parties watching their own property.

Merchants usually attend very closely to the care of their bullion in weighing, muster cutting, &c. &c. &c.

Check complete.

24. After a bar of melted metal has been brought to a

perfectly homogeneous condition, that is uniformity of fineness throughout, and its net weight has been ascertained, the only remaining step necessary for the calculation of its value is the process of assay to determine what that fineness is; and even in this difficult stage of the valuation, we conceive that the utmost possible satisfaction is provided on all hands, because agreeably to the system already described, the process is in fact as good as executed under the joint superintendence of the persons interested in it.

Check upon the assay.

25. This assertion, which may appear somewhat paradoxical without explanation, will perhaps be made more intelligible, if we give a further illustration showing the working of the principle upon which it it based. Let us suppose then that it were possible for a *machine* to be so constructed, as in the form of a chest to contain within itself all the means and materials for carrying on the process of assaying; and that, as one may often hear of other contrivances of modern mechanism, it were so contrived as, on putting a muster of silver or gold on one side of this chest, it was in due course operated upon by the machinery within, and after a short time, the finished result, or a correct statement of the fineness of the metal made its appearance at the opposite side.

Illustration of the principle of the check upon the assay.

26. Let us suppose that a machine of this kind were used in the Mint Bullion Office for valuation, in conjunction with the Mint scales, and that the Mint Officers and importer, after preparing a melted bar and ascertaining its net weight in the first instance, next cut off from each end the musters for assay, and introduced them, one by one successively, into the self-acting instrument above alluded to, which immediately afterwards exhibited the result in a

Supposed use of an assaying instrument.

Detail of the supposed use of such an instrument.

distinct written announcement of the fineness of the bar they belonged to. If it be assumed that the instrument were capable of giving an unerring result, and such is the hypothesis on the present occasion, nothing more could be desired than that all the parties interested should witness the introduction of the sample into it, and on the completion of the operation assure themselves as to the result; which when adapted to the calculation, would accurately determine the value required.

27. If such a machine were known to be, as above supposed, competent to give an *unerring* report, there could not be the smallest hesitation in accepting a valuation arrived at in the above manner. Like the indications of the common balance, its report would have only to be seen to be instantly received and trusted to. But if, on the other hand, it were found that the instrument was not universally correct, but was liable occasionally to derangement, so as to cause it to give a wrong answer; some doubt, in proportion to the frequency of the errors known to take place, might naturally arise, particularly in those instances wherein the result exhibited by it should be found to differ from expectation. In such cases, when a doubt arose, the obvious remedy which would suggest itself would be to make a second trial of the same musters, and see if the answer were the same as before, or not. If it were, then the first result would be confirmed, but if a difference were shown, the discrepancy would be cleared up by a third trial.

Nature of the satisfaction obtained by such an instrument.

28. Now, admitting the possibility of occasional slight errors in such a machine, it appears to us that the absolute freedom of re-trial which it affords would completely obviate the difficulties of it, and give confidence to the parties interested in its accura-

If exact, or only liable to occasional error, its

use would be satisfactory.

cy; which would be made quite perfect if, for the reasons hereafter given, (para 40,) there were also the same facility in India, as in Europe, for a reference to another assaying machine in case of necessity; and thus, seeing that the whole of the steps of the valuation, from the first weighing of the crude bullion up to the moment of the insertion of the musters into the assaying instrument, are watched by the parties interested; that the result obtained by it is exhibited in their presence, and that any trifling derangements in its working can be detected and remedied by repetition, there does not appear to exist the smallest possibility of any error which they have not opportunity for becoming congnizant of, and freedom to correct.

It would complete the evidence of all the steps of the valuation.

29. Facilities such as these, when they are proved to be possible, both the Public on the one hand, and the Officers of Government on the other, have a right to demand should be afforded to them; and although with honourable and upright men in the employ of Government as Assayers, it might perhaps to some appear to be sufficient that the Merchants should be paid according to their discretion, and trusting to their integrity, still as the basis of a system and the foundation of rules, we cannot think any system can be considered unexceptionable, in which the agents on both sides in the vast dealings which take place in the business of the various Mints, are not afforded the fullest possible insight and scrutiny into the whole of the proceedings connected with the valuation of the bullion, and the most perfect facility for guarding against mistakes or frauds in the results; instead of being, as at present in some Mints, called upon to take on trust the most important element in the whole calculation.

Perfect facility for the discovery of frauds ought to be afforded in all Mint transactions.

No system of management complete without this.

30. It will no doubt have been perceived, that in the

above sketch of the fictitious conduct of a scheme of valuation under the inspection of all the parties interested, an exact outline of the practice of the Madras Mint has been given, with the mere substitution of an instrument for assaying, in lieu of the existing Assay department and its Officers and servants. The object has been to make it evident, that however difficult the assay process itself might be, yet that by separating these difficulties, as a totally distinct operation, and making the process, as a whole, subject to check as to the accuracy with which it may be conducted, and dealing only with results, there is in reality no obstacle to making the valuation of bullion throughout its whole course as palpable and satisfactory to the parties concerned in it as the mere weighing of a bar of metal. The arrangement has this advantage, that whilst the result of every process is witnessed by them, the efficiency of the internal management of the Assay Office is exclusively committed to its own proper head; whose fidelity and attention, nevertheless, are not taken for granted, but tested by success in the general accuracy of his reports, and thus open to constant inquiry and verification.

The Madras system a scheme for separating the responsibilities of the Assayer and Mint Officers.

The assay being subject to check.

31. We must also observe, that if the freedom of re-trial, and, in case of need, of appeal to another Assayer be made so complete as to render the security of the assays as nearly as practicable perfect, the direct consequence is not *merely* the satisfaction of the Mint Officers and the importer as to the truth of the valuations made by them, but also the filling up of the conditions requisite to complete the responsibility of the Mint Officers as to the custody and produce of the bullion, which it is so essentially necessary should be unequivocally laid upon them. We may say, indeed, that if by perfect freedom of re-trial and

By this means the responsibility of the Mint as to the value of bullion is established.

appeal, the danger arising from unskilfulness or want of care in an assay made by an independent person, can be so neutralised as to be in reality of no practical moment, we may consider the Mint Master in the same light as if he himself performed the duties of Mint Assayer, by the use of an assaying machine, and hold him entirely responsible for the use made of it, and hence, for the valuation of all the bullion received into his charge. The responsibility is thus clearly fixed upon him, if he be *satisfied* with the sufficiency of the check; and it is so fixed, quite distinctly from the implication of any other person. The check upon this responsibility which has already been fully explained, viz. the comparison of the receipts and out-turn of the Mint is simple, exact, and beyond all evasion. The Assay Master also, as we have before stated, is simply accountable for the truth of the individual assays upon the bits of metal sent to him as "musters," without reference to any other circumstance connected with the history of the metal they belong to, and upon this responsibility there is a distinct check by the repetition of musters.

The responsibility is checked by comparison with out-turn.

32. In the same way too, that the difficult responsibility as to the value of bullion received into custody may be satisfactorily undertaken by the Officers of the Mint, so may that also as to the correct manufacture of the coins in accordance with the "Standard" be assumed and executed. All that is needed for the performance of this duty, is a true statement of the finenesses of the various bars of bullion before their "alligation" or mixture together, and a true statement of the fineness of the resulting pot of metal after mixture. Now, the first of these is necessarily obtained in the course of business, as before explained, on the receipt of the bullion, at the time of its valuation; and the second is procured, as has also been mentioned, by forwarding musters of the "ingots" for assay with

The responsibility as to the manufacture of the coins fixed on the Mint.

Mode in which the duties of it are performed.

the ordinary musters of the day. If the reports of these last, as well as of the others, be accurately stated *to as minute a fraction of fineness as can be depended upon*, it is obvious, that the Mint Officers have an equal power with the Assayer to regulate the fineness of the coins thereby, so as to ensure their conformity to the Standard.

33. We have said enough in a former place, (Chap. II. para 45,) to show that, after all, very minute accuracy in the fineness of *individual* coins is not a matter of so much importance as is sometimes insisted on; though if it were, we are satisfied it could be more easily attained by the Officers of the Mint than by an independent Assay Master.* As it is, with the facilities above mentioned, the former have full power to assume all the responsibilities connected with their own proper duties, viz. the manufacture of the coins, even as to fineness; and the check upon this responsibility is clear and distinct, being achieved by the examination of the coins by the Assay Master in his proper and *independent* character; he not being in any way implicated in the manufacture.

The fineness of the coins better adjusted by Mint Officers than by an independent Assay Master.

34. We thus perceive how, according to the Madras system, the whole of the conditions requisite for a satisfactory discharge of all the duties of a Mint, and which were specified in Chap. III. para 42, are brought about; viz. First. The bullion is valued by the Officers of the Mint, and check-

The Madras system satisfies the conditions of a correct scheme of duty.

* In the seven years from 1841 to 1848, the result of 6,000 assays of coins manufactured in the Madras Mint, where they had been adjusted to Standard by the Mint Officers, without any interference of the Assay department, showed a proportion of 80 per cent to be true "Standard." The like examination of the coins issued from the Calcutta and Bombay Mints, where the finenesses are wholly regulated by the Assay Masters, showed only the proportions of 38 and 35 per cent respectively.

ed on behalf of the Merchants.* Secondly. It is subjected to all the processes of the coinage under the *sole* management and custody of the Mint Officers; and Thirdly. The coins are tested after delivery, on behalf of the Government, by a really independent Officer, the Assay Master.

35. It must be observed also, that the different responsibilities connected with the receipt and custody of the bullion are clearly separated from one another, and placed upon the proper parties, subject to efficient checks. The Mint Officers are responsible that the valuations are correctly made, and they are bound to give *proof* of their precision by producing in Standard coins the full value of metal for which the Government pay. It is impossible for them to defraud the importer, because each step in the valuation is conducted jointly by himself; the precaution being even taken that the arithmetical calculation of value is checked by both the Mint and Assay departments. It is also impossible for the Mint Officers to cheat the Government, because a comparison of the delivery of Standard coins, especially when valued in the manner pointed out in Chap. II. paras 48 and 49, with the money paid by Government for the metal producing them, shows in an instant whether there has been any deficiency or loss. The individuals who bear this responsibility have the exclusive management of all the processes connected with it, and their acquittal therefrom is judged of by the report of an independent Officer.

The different responsibilities kept distinct from one another.

36. Again, the Assay Master, in the business of valuation, has simply to be responsible for the internal working of his own department, the efficiency and precision of which is judged of by the accordance between his reports of the

Assay Master merely responsible for the truth of the report of fineness.

* As the *assays* in this case are not made by a Mint Officer, and all the other steps of valuation are palpable to any ordinary observer, it is unnecessary that the check should be made by an independent *Assayer*, being already complete, as we have explained in the text.

same musters in cases of repetition. He is responsible merely that each assay of a bit of metal reported by him shall be true to the degree of precision declared by him; but he is not, as in Calcutta, held accountable that the bars of metal to which the assay musters belong are correctly charged in the Mint accounts, that is, for the *value* of the bullion. Were the melting department, as is the case in that Presidency, relieved from all concern in the fineness of bullion fused by them, and that responsibility thrown upon the Assay Master, it would then be necessary that the latter should assure himself of the accuracy of *all* the steps of the valuation, because otherwise he could not possibly vouch for the results of them. But such is not the case in Madras, where the Mint Officers are responsible for the real value of the bullion entrusted to them,* and for the "alligation" of the metal as well as all the other executive duties of the coinage, and the Assay Master has no concern whatever with the out-turn of the melting pot, but only with the coins, when these are submitted to him *after* delivery for his certificate of their standard precision.

Not for the accuracy of valuation.

Mint Officers responsible for the value, and the mixture, and out-turn.

37. Of the great importance of the principle of a distinct check upon every duty, which is the peculiarity of the Madras system of Mint management, none will require to be assured who have had an opportunity of learning by personal experience how much constant and unremitting effort it requires to prevent a lax and inefficient course of practice from creeping into a public department in India, even amongst those subject to control and supervision; and who

Great importance of a check upon every duty.

* It must be observed, that in case any bullion is *not* used in the Mint, but sent elsewhere, it must either go on the responsibility of the Mint Officers as to its value, or the Assay Master must be allowed to value it himself, in his own way; the melting, cutting musters, &c., being done under his own superintendence.

are sensible of the inevitable consequences of the absence of all check or scrutiny. We need not, however, insist upon the well established principle, that for duties to be properly performed they must be strictly looked after, which can only be done by establishing checks; though it cannot but be thought wonderful, that a maxim so obvious, and so universally allowed, should not have been more generally attended to in Mint regulations, especially as regards that most important of all duties, the assaying.

Amongst others upon the assay.

38. It is, moreover, a great advantage of the Madras system, that the responsibilities held by the different Officers are limited to the results of duties under their own exclusive control and direction. When the responsibilities of either the Mint or Assay Office are so arranged as to include the duties performed by the other department; as for instance, when the Assay Master is supposed to be responsible for the fineness of the ingots, the results of a mixture melted by the Mint, the seeds of distrust and disagreement are inherent in the very constitution of the scheme, and we can hardly conceive it possible for business to be *strictly* carried on with satisfaction to all parties; as ample scope and temptation is afforded in case of any discrepancy taking place, for mutual recriminations.

Advantage of keeping Officers responsible only for their *own* acts.

Disagreement apt to follow, if the responsibility of one Officer extends to the duties of another.

39. Thus, when the whole responsibility of the valuation is supposed to rest upon the Assay Master, and that as to the accuracy of the produce of the melting pots also, which we believe is the case in Calcutta; besides other objections, it must be obvious that in all cases of apparent serious error, that Officer must be subject to an almost irresistible temptation to accuse of the supposed fraud, the servants belonging to the independent

When the responsibility of assaying is mixed up with that of melting, a strong temptation exists to mutual blame.

establishment, who may have been employed to fuse the alligation; and thus by relieving himself from the blame which would attach to him if the mistake arose from incorrect assaying, to cast the responsibility upon others. By the Madras system each department is accountable only for its *own* work, and submits it to a check independently of all confusion with the acts of others.

Systematic error not discoverable by repetitions.

40. It is a necessary condition for the efficient working of the Madras system, that there should be freedom of occasional reference to another Assay Office, otherwise an inconvenience would be felt to which the system without this provision is liable, viz. that although accidental mistakes in the assaying may be checked by the plan of repetition, no discovery can be made thereby of *systematic* error; and hence much mischief may be done without the means of detection. It is almost needless to explain the truth of this, since it is evident that no repetition could make known a deviation which was universal and constant; for instance, if the Assay Master should think it right to add invariably a half pennyweight to *every* assay reported by him, no conceivable number of repetitions would lead to the exhibition of his habit of doing so. But, though it is necessary to guard against the difficulties this might occasion, if there were no remedy for it, it is to be hoped that in the majority of cases the remedy would be but seldom resorted to; since it may be presumed, that very few Assay Masters would knowingly be guilty of such error, and even should any one from a mistaken view of the professional minutiæ of his business do so, occasional opportunities would be met with which would cause the deviation to become known; as for instance, whenever it might happen that he should be called upon to report the finenesses of samples of already ascertained quality, a test which, in event of any doubt, could be submitted for the

Reference to another Assay Office occasionally desirable.

May be sometimes obviated by using samples of known fineness.

purpose, and which in some cases might disclose the error, and bring about the requisite change of system, with the same effect, and in a less offensive manner, than a formal appeal to the decision of another Assay Office would do.

Objections made against the Madras system.

41. Great objection was at one time made against the Madras system, chiefly on two grounds; First. That the assay department was exposed to the risk of unjust accusations of error, inasmuch as the Officers of the Mint might, either from carelessness or design, mix the "musters," and by then assigning to them improper titles, create the appearance of a discrepancy in the assays, which would have no other cause than their own dishonesty or want of care; and Secondly. On the ground that it requires scientific knowledge to cut the musters for assay, and that therefore the Officers of a Mint are incompetent to perform the duty.

Reply respecting the liability of the Assay Master to unjust accusation.

42. Regarding the first objection we must observe, that it is certainly true to the extent of any importance which may be thought due to it; but it is in fact merely tantamount to this, that the Mint Officers may knowingly make a false accusation of error. Now, if the evidence upon which the proof of such inaccuracy in the assay is founded, contained any step which involved the least doubt or obscurity, it would perhaps be unjust to accept the assertion of its having taken place without some tangible means of realising the truth of the deduction; but with a proceeding of such extreme simplicity as that of the comparison of the assays of two samples cut from the same point of a bar of metal, and submitted at different times, the facility of guarding against the risk of mistake is so great, as to make it out of the question that an accidental cause could give

This cannot occur except by intentional falsehood.

This risk unworthy of notice

rise to the suspicion; and although the Assay Master would still be open to the risk of a totally false charge, resting on mere fabrication, the real *probability* of such being ever made is in fact not worthy of consideration.

43. On the contrary, it is not to be doubted, but that no public Officer would venture to impugn the character or skill of another, without the most cogent sense of his duty to do so, and an absolute conviction of its truth, which for the reason stated above, could not be a mistaken one; besides which, the superior authorities to whom such an accusation must in the first instance be made, would themselves attach importance to it, in proportion to the opinion they entertained of the integrity and discretion of the party making it; so that in case of there being the least probability of such an accusation having been falsely preferred, they would assuredly receive it, not without distrust and hesitation.

Both the Mint Master and Mint Committee would be reluctant to entertain suspicions of the accuracy of the Assay Master.

44. Moreover, the Assay Master, as manager of an independent Assay Office, according to the Madras scheme, stands in the same situation as the Assayer of every other public Office in all parts of the world. The latter is open to false accusation by the whole Public, and has to deal with individuals of all kinds, with no other defence than the known integrity of his own character, and the accuracy of his work. And in the Indian Mints too, the assay Offices are by regulation open to the use of the Public, so that for a small fee, any person may procure an assay in the same way as in Europe. The Officers in charge of them are thus liable to misrepresentation by any person whatever who can command money enough to pay the fee, however low his cha-

The Assay Master, as manager of an independent office, not more liable to unjust accusation than the manager of every public Assay Office all over the world.

racter or position may be; and it seems to be unreasonable that the Assay Master, while he is obliged to consent to lay himself open to injury from any person, by accepting sealed packets of musters from the Public, should take a solitary exception against this mode of doing business with an Officer holding a situation of great trust and responsibility.

The Assay Master is unavoidably open to aspersion, as his Office is by regulation a public one.

45. We must observe, however, in conclusion upon this point, that the system of management which involves the above objection, does not profess to have attained perfection, to accomplish which it might be necessary, perhaps, that *nothing* should be trusted to *any one*. By the scheme which has been above described, there can be no doubt that an improvement has been made upon the method of trusting *every* thing to the Assay Master, and taking all the assays for granted. But, while a great step has been taken in doing away with the ruinous effects of that most dangerous kind of trust, it has not been possible to do away with all trusts whatever; notwithstanding those which have been allowed to remain are of a character which, we think, may be tolerated with infinitely less risk. A valuable system of check upon the correctness of the assays has been contrived, but the carrying out of the arrangement, necessarily involves some confidence to be reposed mutually by the Mint and Assay Masters in one another. By the former, it must necessarily be taken for granted, that the Assay Master is generally competent, anxious to do his duty, and incapable of trying to deceive him; for in that case, he would have but little difficulty in effecting his object, and the Mint Master could not avoid the greatest risks; by the latter it must be equally assumed, that the Mint Master is true in his statements of error, and would not make a public accusation without taking pains to guard against mistake; but these assumptions on

Mutual confidence between the Mint and Assay Masters necessary.

either side may, we think, be safely made with Officers of the high character usually appointed to the respective situations; and, therefore, viewing the scheme generally, as the best practicable substitute for the great inconveniencies of the want of a Mint Assayer, they can hardly be looked upon as a very serious objection to it.

Without *some* trust in the Assay Master, great impediments to business would exist.

46. Indeed, if great confidence were not placed in the belief of the Assay Master's habitual endeavour to do right, the delays and difficulties of carrying on business in both departments would be immensely increased. In the absence of *all* trust, it would be absolutely necessary to have one, if not more repetitions of *every* assay; the labour and delays consequent upon which, we can easily understand. It is, therefore, only *unintentional* errors which are sought to be remedied, and against these the scheme above described affords a perfectly sufficient safeguard; and it is, perhaps, a recommendation of the peculiar process of check, that the amount of extra labour imposed upon the assay department, which is necessary to guard against defects in the manufacture, and to establish and maintain the confidence of the Mint, varies in exact proportion to the frequency of the errors which are met with; or in other words, to the carelessness which gives rise to the necessity for the repetitions.

The checks prevent errors, or show who is to blame.

47. It may be doubted, perhaps, whether the mere discovery of errors by means of checks, necessarily involves their remedy, and cases may be imagined in which this might be very seriously felt; but, as has just been observed, the system under review is not to be judged as if it professed to be a theoretically perfect constitution, but only as the best, and in all ordinary, indeed any but the *most* inauspicious circumstances, sufficient substitute for an unexceptionable scheme. While it is true, therefore, that the checks,

though they may disclose, cannot put a stop to errors, it may be added, that they do in great measure obviate the evil consequences which would result from them, by preventing the errors from influencing the coinage; and, beyond this, if after all the precautions which can be taken by the Officers of the Mint, and every endeavour by the use of repetitions, to guard against discrepancies, mistakes arising from faulty assaying should still occur, the check may at last be appealed to, to decide where the cause of error originated, and to show clearly what party is to blame. If more be required, it is evident that the higher authorities must interfere, and whenever the work of the Mint is thrown into confusion by the inefficiency of the performance of the *executive* assay duties, the Mint Master has no alternative but to appeal to them for assistance and support; but we should think this case would rarely occur.

Objection that it requires science to cut musters, replied to.

48. In regard to the objection founded on the scientific knowledge required to cut musters, we may say that it is one without foundation, as we think it a mistake to suppose that it requires any skill or science to cut the musters sent for assay. That it is a duty which may be carelessly and improperly done, may be true, just as much as the weighing of a bar of metal, or any other act which merely requires the exercise of common sense, and a determination to do what is right; but it is erroneous to suppose that even the least scientific knowledge is necessary to perform it, and still more, that if it did, the skill of an Assayer is peculiarly necessary. Were any experience required, it would be the experience of the melter who casts and prepares the ingots and bars, and who, if any one, might form a guess as to the possibility of variations in the quality of different parts of it: but to assert that the knowledge of an Assayer is necessary to detach a sample for examination,

It does not require the skill of an Assayer to cut musters.

is as unreasonable as to assert that no one could tap a cask of wine but the man who was to taste and report upon it, or that no one could cut off a sample of woollen, but the hosier who was consulted to give a judgment as to its quality.*

49. Admitting, however, for the sake of argument, that it were possible to cut a muster improperly from a perfectly homogeneous bar, (such a muster as would be received by the Assayer and submitted to examination,) it would even then be better that it should be done by the joint concurrence of the parties interested in it, than by the Assay Master or any other person. If those parties allow an error to take place, they must do so at their own expense, but if a third party were granted the authority to direct operations arbitrarily, he might, if so inclined, persist in doing wrong to the injury of others who had no remedy for his misconduct.

Even if musters are wrongly cut, it is better that the parties interested should do this.

50. It is, however, needless to argue upon the above supposition, because, unless a previous fraud has taken place in the melting, there is no

There cannot be wrong musters cut, unless the

* It has been objected to this, that in a coarse bar especially, too much of the black oxydised surface may be cut off with the muster, and which, if used in the assay, would prejudice the result, and that it *does* require care to avoid this. But we are of opinion this does not affect the question. It is possible, we admit, to send the Assayer a muster cut from part of the bar covered with oxide, or any other kind of dirt, but that has nothing to do with the assay. It is the duty of the Assayer, out of the metal sent him for report, and which is two or three times as much as is necessary, to take that which is suited to an unexceptionable assay, and avoid whatever might affect the result injuriously. The Mint Officer or Merchant who cuts and sends a "muster," is not cutting out the assay sample or unit, but merely a crude mass from which the latter is taken. It is the Assayer's fault, if *it* contains any foreign substance. Besides which, if the muster were so improperly cut as to preclude the possibility of making a correct assay, nothing could be easier than for the Assay Master to return it.

melting of the bar has been improperly done.

possible means of committing any act of dishonesty in cutting the musters. If a fraud had taken place, spite of the melting being conducted under the immediate direction of the parties interested in the result, no skill of the Assayer would enable him, either to detect it at the time of cutting the musters, or so to detach them as to obviate the effects of it; and if none had taken place, no skill whatever is required.

51. The argument on this subject, indeed, lies in a nut shell. If the bar to be valued has been properly melted, and is *homogeneous*, no art is required to detach the musters from it, and no fraud in doing so can be purposely committed. If the bar, however, be *not* homogeneous, no art of the Assayer can tell him so, until by examining the musters cut by any person in the usual way, he has ascertained that there is a difference of fineness between the different parts; and no remedy is proper but that of re-melting the bar, and bringing the whole mass to a condition of uniformity fit for valuation.

With a homogeneous bar, the musters cannot be incorrect; in an irregular bar they cannot be otherwise.

52. Finally, if it requires science to cut musters, it may well be asked, how could the business of all the chief cities of Europe be carried on as at present, by means of musters cut by unscientific persons? The answer is exactly what we have already said, viz. that the musters cut for transmission to the Assay Office, are merely larger pieces from which the true "musters" are taken by the Assayer, and it is absurd to suppose that the separation of the former requires science.

If science be needed to cut musters, Merchants' bullion could not be assayed, as at present, in ordinary Assay Offices.

53. In the above details, we have given the outlines of an arrangement whereby all the necessary conditions for maintaining the integrity and distinctness of the various responsibilities connected with a Mint are realised, according to the practice carried into effect in Madras for many years. Since

Original Madras system not now carried out exactly.

the re-establishment of the Mint there in 1841, however, a rather different scheme has been in operation, some modifications having been made in it by the Madras Government, in consequence of a reference to the Government of India by the Assay Master, who was desirous that it should have been set aside, and a totally different course of proceeding established. The result of the reference was the approval of the Madras system by the Supreme authorities; but owing to misapprehension of an allusion contained in the despatch, to the different state of things in the Calcutta Mint, it was supposed by the local authorities that an alteration was intended, which was accordingly carried into effect; to the great injury of the simplicity and soundness of the system, and ruin of the peace of those employed to carry it out. But, although thus impaired, and having besides to struggle against very unusual difficulties, it has, nevertheless, been the means of realising effects* which establish its claim to approbation; and prove that under circumstances which may be reasonably supposed to be of general, if not universal occurrence, it is capable of effecting all the objects desired.

Alterations made in 1841 were very injurious to it.

Nevertheless, in spite of many disadvantages, the results are on the whole very favorable.

* We have already mentioned in the notes to Chap. II. para 56 page 67, and Chap. IV. para 33 page 118, that upon a full examination of the whole coinage issued from the Madras Mint since 1841, the results had been that eighty per cent were exact Standard, and the average deviation of the entire issue less than $\frac{1}{50}$th of a pennyweight, or within half a grain in the pound Troy, on the side of "Betterness." On the subject of the custody and produce of the bullion we may add, that upon the whole coinage above referred to, of two hundred and one and a half lacs of rupees worth of bullion, there has been a net excess delivered to the Government, arising from the "return of the assay," or unreported fractions, referred to in Chap. II. para 32 page 57, amounting to the value of rupees 10,937. This excess would probably have been greater, but for the trifling excess of fineness in the coins, which thereby contained about two thousand rupees worth more pure silver than they ought to have done; and also because we have reason to think that, possibly through inadvertence, the unreported fractions were not *always* in favor of the Mint.

CHAPTER V.

The internal checks which are employed, in connection with the system described in Chapter IV.

1. In the preceding pages, we have been exclusively occupied in the consideration of the checks instituted by Government for its own satisfaction, as to the correct performance of the duties of the Mint, taken as a whole; we think it may now be advisable to make a few very brief observations upon those which relate to the internal management of the department. The checks to which we now refer, form that organization whereby the department is qualified to discharge the trusts confided to it, and satisfactorily acquit itself thereof by submission to the ordeal which the Government requires it to undergo. They are such as provide for the security of the bullion while within the walls of the establishment, and for the regulation of the proper agency whereby the true standard of the coins is obtained, the economy of the manufacture observed, and the careful execution of the pieces regulated, though on these two last points we shall not think it necessary to make any remarks.

Difference between external and internal checks.

2. To avoid misapprehension, we will venture to repeat, that the system of checks we have now to remark

upon are those which the head of the Mint institutes, to enable him to perform his duty, and acquit himself thereof by the tests established by the Government. They are, therefore, essentially distinct from the latter, and ought not to be confounded with them. The one series constitutes the internal economy necessary for the management of the Mint; the other, the external regulations to which the department is subjected, with the former of them we have now to do.

3. And here we must observe, that there is a great difference between a system of check, properly so called, and a system of precaution merely; and as it is a point upon which many persons are apt to entertain erroneous impressions, we think it very desirable that this difference should be pointed out. In the former case, the responsibility is transferred to, and fixed upon the agents employed, who are called to acquit themselves thereof when their duty is performed; in the latter, the responsibility still remains with the employer, and he endeavours to protect himself against the consequences of fraud, by watching over the proceedings of the agents, by means of others, or as they are termed, check Officers, upon whose faithfulness and vigilance he is entirely dependent for his safety.

Difference between a check and precaution.

4. We may illustrate this by putting a case which will be more easily comprehended, than the abstract proposition above stated. If an employer has occasion to use the services of an agent in making extensive and various payments, and for this purpose has to entrust him with a large sum of money, he may adopt two methods of securing himself against this agent's dishonesty. In the one case, he may put into his hands an untold amount of cash, and send him on his duty, appointing two or three, or more persons, vigilantly to watch his proceedings, and to take

Illustration of this difference.

care that none of the money be lost or misappropriated; in which case, we believe, judging from the opinions we have heard expressed on these subjects, that the Public, seeing the busy interference of the many watchmen, would be inclined to approve what they would erroneously consider a strict system of "check;" or Secondly, the employer might count the money, take security from the agent, and leave him to go free; merely telling him that he would have to give an account on his return, and produce vouchers for all his payments; and in this latter case we think it likely that a spectator, judging only from *appearances*, would be apt to reprobate what he would consider to be a negligent and lax system of over-weening confidence, not being aware of the ample security of the provisions with which it was connected.

Checks used in the Madras Mint.

5. Thus, an internal system, founded upon the principle of employing a series of watchmen in every different department of the Mint, under the management and control of a Bullion-keeper, who is supposed to be responsible for the safety of the precious metal, has been proposed as a model for general imitation. The Madras system, which is that of a simple check which will be presently described, has at times struck visitors with the idea that the bullion was exposed to danger, because they could see no elaborate precautions for its safety, which indeed would only have been indispensable if there had not been a sufficient check; and because they had no means of learning the completeness of the system by which such watching is rendered superfluous.

6. We cannot but think, however, that in a Mint, a scheme of checks is immeasurably more secure and efficient than any watching system whatever; not to mention its being more economical, inasmuch as it dispenses with the many agents required in the latter case. For, putting out of

A system of checks much the best.

view the great danger there is every where, and in India the almost certainty, of being robbed by the agency or connivance of the very watchmen themselves, it is in our opinion quite certain, that, let the number of such watchmen be multiplied to whatever extent we may think fit, no care can be so incessant, no precision so scrupulous, no vigilance so untiring, but what the multitude of inferior workmen employed throughout the vast manufactory of the precious metals, when released from personal responsibility, would find abundant opportunities of escaping from their operation.

7. In Madras, the simple arrangement as to the custody of the bullion is, that the various internal departments check *one another;* each being separately responsible to the Head of the whole establishment, and acquitting itself by comparison of its receipts and issues. The head of each department is the professional superintendent of the process carried on in it, and besides being chosen as a man of character and responsibility, gives security for the faithful discharge of the trusts confided to him. Although the salaries are small, there has never yet been any difficulty in finding such men, and the arrangement is an essential part of the system, as the changes of weight necessarily involved in the manipulation of the metal, would effectually prevent any satisfactory adjustment of accounts between the Mint Master and the different departments, if the parties were not mutually cognizant of them; unless, indeed, a system of allowances for loss were established, which in fact is virtually a kind of contract, whereby the Government pays, and that largely, for inattention to these particulars.

Madras system of check described.

8. Ever since a short period subsequent to the recommencement of operations in 1841, the principle has been adopted and followed out, which is treated of more fully in the Appendix, viz. that of there being no such

No waste allowed

thing as "unavoidable waste" in the fabrication of coins. This is a principle, however, which although true, can only be applied to the dealings between the Government and the Head of the Mint; and when that Officer happens to be a professional person, there ought to be no doubt about its recognition, or difficulty in carrying it out; but under other circumstances there might be an obstacle to the realisation of its advantages, because as we have before explained, it is only by a study of the entire course of manipulation, and close observation of the effects of each particular process, that the just influence of each upon the whole mass of bullion can be allowed for, and prompt and effectual measures taken to guard against its being made away with.

The departmental accounts checked in connection with one another

9. Although each Superintendent of a department of the Mint is equally accountable to the Mint Master to return the full value of bullion entrusted to him, yet the nature of the account kept in each particular case is very different, and it is in checking these accounts that the skill of the Mint Master is most called for, and upon this that the success of his management mainly depends. The chief difficulty arises from the frequent disturbances of the departmental accounts, by slight unintentional gains and losses of one at the expense of another, which prevent exact uniformity in the results; and also the incalculable effects in some of the departments, of changes in the manipulation which it may be necessary for various reasons to make. Viewing, however, as he does, the whole of these accounts simultaneously, the Mint Master is able to allow for trifling variations, plus and minus, in them individually, if he perceives that they compensate for one another; and when by the results of a sufficient experience he is able to judge accurately as to the influence of each of the different processes

of manufacture upon the weight and fineness of the metal, he is enabled to make allowance for those fluctuations which may be caused by alterations in them; more especially if, by the accurate measure afforded him in the numerous assays of the pyx coins, he can establish a satisfactory comparison between the true value of the total receipts and deliveries of the Mint.

10. The usual results of the manipulation in each of the different departments are given in detail in the accompanying Appendix; it is therefore merely necessary in this place to mention, that the first responsible Officer who takes charge of bullion handed over by the Merchant, is the bullion-keeper, in whose accounts it stands at the net weight and fineness shown by the assay. By him it is transferred to the melter, at the same rates, and consequently at the same value; the metal having undergone no change while in his custody. The melter's delivery, in clean ingots fit for coinage, is rated at their net weights and true finenesses as shown by the assay, and he delivers a full equivalent of the value received, besides a surplus corresponding with the "return of the assay" or fractional excess upon all the bullion melted by him for the first time. The Superintendent of the laminating, cutting, and adjusting departments receives and delivers by weight only, and this species of account, added to that of the number of pieces, is continued till the final delivery of the coins to the Government General Treasury.

Nature of the accounts in each department.

11. As each Superintendent is master of the processes carried on under his direction, and gives security for the faithful restoration of all bullion confided to him, agreeably to the satisfaction of the Mint Master, nothing but want of sufficient experience or attention in the latter could give rise to any thing like an unobserved deficiency of serious

Deficiency may be traced.

magnitude; with ordinary care, such a fraud would not only be detected in the deficiency of the general outturn, but traced to the department where it took its origin, and charged to the account of the Superintendent responsible for it.

Other checks and precautions employed.

12. Thus far the Mint Master is secured in the maintenance of his responsibility; the Superintendents avail themselves of the ordinary checks and precautions for guarding themselves against loss. The balances of metal under manipulation are daily removed to the strong room and there locked up in stone vaults, under the protection of a military guard; the workmen are strictly searched in every room, besides the final examination at the Mint Gate; a daily examination and report to the Office of the gross amount of balance in each room is made, and a weekly one, stating the particulars in detail; and lastly, a half-yearly clearance of the Mint takes place, at which all silver contained in the refuse is extracted, the balances are actually produced in solid metal, and the accounts relating to the preceding period or "settlement," finally closed.

Nature of the check upon the whole Mint.

13. On each of these occasions, at the time of "Settlement," after the whole of the internal deliveries have been made, and when the final balances of the different departments have been collected together, a register is prepared, showing the exact weights and finenesses, according to the Assay Master's report, of all the bullion remaining in the Mint; and on a fixed day, the bars are laid out for inspection, and one of the members of the Mint Committee attends with an assistant, by whom they are examined, their weights tested, and their Mint numbers compared with their weights and the register. The only part of the Mint deliveries which is not, and cannot be, tested on this occasion, is the value of the precious metal which,

after the profitable extraction has been carried to the uttermost, still remains in the refuse; this, which is usually very trifling,* is estimated by the Assay Master; the accounts of the Mint are then made up and submitted to Government.

Power vested in the Superintendents of the departments.

14. It may be necessary to add to the above statement of the checks and precautions observed for the preservation of the bullion, that it has been adopted as a principle ever since the above scheme of checks has been strictly enforced, to vest considerable power in the head of each department; and the system followed by each, is that of securing, as far as possible, the services in his own room of trust-worthy men for *every* situation, so as in every part to have the assistance of those generally interested in the welfare of the department, in lieu of the services of paid watchmen. In fact, all the servants in each subordinate department are interested in preventing fraud or peculation, the whole being generally responsible for loss.

Truth the great basis of accuracy.

15. And lastly, on the subject of the means employed for the security and preservation of the bullion, we must not forget to mention, that the grand object in each transaction connected with the valuation on receipt, and the great desire felt by every one of the parties connected with its custody is, that the results shall be bonâ fide in as close accordance with the *truth* as possible. With this view no bullion, either public or private, is ever received upon any hypothetical or conventional valuation. The me-

* The aggregate value of the silver particles contained in all the drosses remaining at twelve half-yearly settlements was, according to the Assay Master's report, rupees 1,241-10-8 or, on an average, rupees 103-7-6 The whole amount in value of bullion coined during the above period being rupees 200,80,295-10, or on an average, rupees 16,73,357-15-6 each settlement. The above drosses sold at auction for rupees 816-5-3, so that there was an average loss by the sale of rupees 35-7-1.

thods of cutting, burning, and sampling, adopted elsewhere for the sake of despatch, are never admitted, as giving cover to various sources of error and uncertainty in the estimated quantity of impurities, such as dirt, grease, metallic oxides, &c., and thus throwing a shade of doubt as to the precise value of the whole, which precludes all exactness in the accounts of delivery.

Assays must be founded exclusively on the results of the process.

16. As a fundamental principle, the department claims to be debited merely with the true value of solid clean metal at its actual assay; and desires that the report of this process shall be prepared by exclusive reference to the actual condition of the metal, in the absence of all other information, owing to the disturbing influence which such knowledge has been occasionally found to exercise on the unbiassed report of the actual fineness of different species of bullion. These conditions are necessary, because it is to the *value* of the precious metal during its progress through the Mint, and not its weight merely, that attention is principally directed. It is only by great care in the receipt, as well as in the out-turn, that the causes of apparent waste being put a stop to, peculation can be immediately detected, and a punctual and exact surrender of all the precious metal entrusted to the Mint, rendered practicable.

Checks as to fineness.

17. Thus far, we have endeavoured to exhibit the chief points kept in view with respect to the security of bullion in charge of the Mint; we will now proceed to touch upon the other great executive responsibility, viz. that as to the regulation of the fineness of the coins to true "Standard," which is necessarily included in the other; it being obvious that the preservation of the bullion requires the correct adjustment of the proportion of pure silver put into the coins, without due attention to which, very extensive losses

might take place, without their attracting observation.* The details of the plan by which the exact adjustment of the *whole mass* of the currency is effected with precision, will be found in the Appendix following, para 52, so that it is unnecessary to enter into any particulars on the subject in this place. We shall, therefore, merely state what checks are made use of, to guard against the consequences of neglect and carelessness, which every Indian Mint Master has so constantly to strive against, in order to avoid mistakes.

Checks on the ingots laminated.

18. In regard to discrepancies in fineness, it must be observed, that the great point which requires attention is that of preventing any metal being passed forward to the laminating department, from that of the melter, or from any other source, but such as has been assayed and is considered fit for coinage. This object is secured in the following manner: On first receipt, the bullion is kept under the joint custody of the Merchant and the Bullion-keeper of the Mint; subsequently, under that of the Bullion-keeper. On the bullion being assayed, the alligations are prepared in the Mint Office, and instructions sent to the Bullion-keeper and melter specifying the metal which is to be melted. After being melted in alligation, the ingots which are the result of that process are stamped with the Mint number belonging to them, and locked up in a strong cellar, under the joint custody of the Superintendent of the melting-room and the Bullion-keeper, until the assay report upon the "pots" is received, the Mint numbers of all the successive meltings being in the mean time inscribed in a book kept for the purpose. On the receipt of the assay report, the Mint Master with the *original* document before him, gives his written directions for the disposal of the ingots of every pot, according to the result therein reported; and those which are then

* Vide Note to Art. 23, page 84.

ordered to be used for coinage, are not merely handed over upon that order, but a register pass is made out in duplicate, specifying the Mint number of each pot so passed, the number of ingots belonging to it, and their fineness; one copy of which is addressed to the Superintendent of the Laminating-room, directing him to receive, the other to the Superintendent of the Melting-room, directing him to deliver these particular meltings, they are then transferred as follows.

Mode of transfer.

19. In all cases, the weighing of bullion transferred from one department to another, is made in the Mint Treasury or bullion-room, and attended by both the receiving and delivering parties, besides the Officers of the Bullion department, who are responsible that justice is done. No objection against the accuracy of the weight declared on transfer is allowed to be made after the bullion has left the room, but any objection made at the time of weighing is decided by the Officers of the bullion-room, or referred to the Mint Master. At the time of weighing, the ingots are examined singly by the parties, to see that their numbers are correct, and when the weighment is finished, the delivery is completed; but the individual ingots have still a further examination to undergo on arrival at the Laminating-room; where, to guard against the possibility of such an accident as the fabrication of coins out of an improper ingot, it is the assigned duty of three persons successively to compare every ingot singly with the register pass, bearing the Mint Master's signature, and satisfy himself that it is correct, for which they are all made responsible.

Further securities.

20. The laminating premises are quite in an opposite part of the Mint, and at a distance from the melting-room, and the cellars in which the two departments lock up their bullion at night are quite distinct; moreover, after a transfer of bullion

has been once made, the receiving department is responsible for the re-production of the metal entrusted to it. There are, therefore, no further precautions necessary, after the metal has once been passed into work, to avoid its mixture with other qualities of bullion, except we may mention, that no meltings of any precious metal whatever, such as bits, particles, recoveries from dross, &c., are allowed to be made any where, except in the authorised melting-rooms, whence they pass through the regular routine of subjection to assay, alligation, &c., the object of which regulation is to prevent the *possibility* of any metal other than that passed by the Mint Master, existing in the coining departments. And further, as a check against the risk of any attempt at the introduction of base metal by the subordinates, or the danger of delivering inaccurate pieces, owing to a mistake in the assay report, or any other cause, the check described in Chapter III., the first part of para 21 page 111, is also kept in daily exercise.

Checks as to weight.

21. The weights of all the individual coins being adjusted by machinery, and consequently less liable to the errors which are so apt to be occasioned by carelessness or neglect in the operatives, no very strict check is required to guard against discrepancies. The pieces are, nevertheless, examined singly before leaving the adjusting room, and also once more in the Mint Treasury previous to despatch; the latter precaution being taken, lest in the course of the processes subsequent to the first adjustment, and especially in the stamping, any one of them might have received an injury, and thus have become unfit for circulation.

22. The Mint Master, as head executive Officer, is responsible for the expenses of the department, which are checked by him necessarily, as no extra work is undertaken without his immediate sanction; and in like man-

Expenses of the Mint.

ner all the ordinary expenses are in the first instance incurred under his directions, with the sanction of Government. In Madras, there is a fixed establishment of the Mint, consisting of the chief subordinate Officers, and a few of the most skilful workmen, who are retained even when there is a temporary cessation of business. All the rest are artificers and labourers upon daily and monthly hire, denominated the "contingent list," whose services are engaged and dispensed with as occasion requires. In a similar manner, the chief articles of consumption, such as lead, iron, steel, copper, &c., are kept in stock in the Mint stores, and accounted for in the Mint books; the commoner articles, which are of local supply, or of a trifling character, are purchased in the market, and the bills submitted to Government monthly for sanction. Once in each year the journals and ledger are forwarded to Government, for the information of the Court of Directors, and the accounts for the official year closed.

23. During the last two years the annual expenses have been somewhat less than 100,000 rupees,* the number of pieces struck having been rather more than twenty-one millions in each year, six and a half of silver and fourteen and a half of copper.

* This includes the Mint Master's salary and *every* expense of the Mint, ordinary and extraordinary, in coining, refining, manufacture of acids, making and repairing the machinery, &c. &c.; but not the expenses of the Mint Committee or Assay Offices, which would, together, amount to about 30,000 rupees more.

APPENDIX.

MEMORANDUM ON WASTE IN COINAGE.

Extracted from the Professional Papers of the Madras Engineers, Vol. II. p. 127.

1. As it is the professed object of our volume to record the experience of each officer in his peculiar province, for the benefit of those who may not have had similar opportunities of observation, and as some of the practical subjects connected with the management of Mints are peculiarly foreign to the ordinary pursuits and experience of the Engineer, I am induced to make a record of the few facts which have come under my observation, even during the short period of my connection with the Madras Mint, insignificant as they are, in the hope that they may not be without interest and usefulness to those who may be for the first time compelled to enter upon a study of the subject.

2. I am the more encouraged to enter upon these details, because, though I am conscious of my inability to bring to light any new facts, still I am of opinion that some benefit may be derived from a careful attention to those which are already well known; and as the object which I have in view in what I am about to bring forward, is the establishment of a principle which has not yet been recognised, and which I am of opinion may perhaps be considered

of importance to the future economy and strict check over the complicated processes of the manufacture of coins, I trust that my endeavours to elucidate the subject, and to clear the way of some of the difficulties which impede the progress of the newly appointed Mint Master, may not be altogether unavailing.

3. The principle which I wish to establish is this, that in the ordinary processes of coining *there is no such thing as wastage, or loss.* I mention the ordinary processes of coining, because I wish to confine myself at present within those limits which strictly comprise matters of my own personal experience, and my acquaintance with the subject is of too recent a date to allow me to include the extraordinary duties which Mints are sometimes called upon to fulfil, more especially the refining of the precious metals, and their chemical separation from one another. During the four years that I have had charge of the Mint, little or nothing has been done in the way of these processes, so that there has been no opportunity for the thorough investigation of them; and therefore, though I feel convinced from the general reasoning which applies to all such processes equally, that the same result must upon a thorough investigation be found true regarding them also, still I feel it necessary on this occasion to limit my observations to those with which I feel myself more thoroughly conversant, and which, from their being of the most constant occurrence, are for practical purposes of the largest importance.

4. I am aware that the subject which I am now about to discuss is not brought under consideration for the first time, and on the contrary, that it has been a matter of attentive scrutiny and examination ever since Mints have been conducted under European agency. Nor am I ignorant that the question is supposed to have been decided in direct opposition to my views; and that the authorities vested with the controling powers of various Mints have not only from time to time admitted the existence of unavoidable wastage, generally, but have even gone the length of reducing the principle to a regular system, and have assigned to each individual process its share in the general loss. I have also been fortunate enough to obtain access to the very valuable report, containing a masterly analysis of the subject, by the late James Prinsep, Esq., Assay

Master of the Calcutta Mint, wherein a review is taken of an extensive series of experiments conducted under the superintendence of himself and the late Dr. Bannister, and also of a similar series in the Bombay Mint by Captain McGillivray, and a comparison made, whereby the results experienced in the two Mints are shown to be in strict accordance with one another.

5. The facts contained in the official papers above referred to are, without doubt, strictly correct, and the inferences drawn from them equally so; nevertheless I trust I shall be able to show that the proposition I have advanced is still absolutely true, and not incompatible with these facts and inferences, although it is altogether at variance with the general deduction which has been drawn from them, and too long acted upon, viz. the inevitable necessity of wastage and loss in coining; and I think it will be shown that it is only in consequence of a *partial* view having been taken of all the truths connected with the subject, that this erroneous opinion has so long been allowed to remain in force.

6. On my first connection with the Mint, my attention was forcibly drawn to this question. I observed that a large wastage had been, year by year, practically experienced in the Indian Mints;* that the regulations of some of them expressly provided for "unavoidable wastage in the operations of the coinage," and that in the official correspondence it was invariably treated as the cause of a real deficiency and a positive loss to the State. All this was quite unintelligible to me. Upon general principles, the occurrence of unavoidable waste in the few simple processes to which I saw the metal subjected, seemed to me to be unaccountable; and observing also the fact, that nothing in the shape of refuse was ever removed from the departments without undergoing a strict search for any particles of precious metal which might be contained in it, the quantity of which was estimated, and an allowance made in the accounts, it seemed to me to be quite impossible that there should still be any real deficiency, or any opening by which so large a quantity as that supposed to be annually dissipated, could be removed or lost sight of.

* This must have amounted to upwards of a lac of rupees per annum, in all the Mints, a few years ago.

7. My reasons for these doubts will appear more clearly, if we for a moment turn our attention to the well known physical truth that matter is not destroyed; that there is no such thing in fact as *destruction* of matter of any kind.* This assertion may appear rash and unwarrantable to those who are unfamiliar with philosophical truths, but it is one so thoroughly established, and so fully known, that it would be a waste of time to attempt an argument in support of an admitted postulate. It is a truth equally universal as it is undeniable, that there exists no such thing as the annihilation of matter. A metal for instance, may be reduced to powder, or it may be dissolved; it may be converted into a salt, it may be changed into a hundred different forms; but still, after each or all these metamorphoses it remains undiminished. If proper means be used, every particle of the original metal may be restored to its primitive condition, without loss. All the efforts of the whole creation could not annihilate a single particle of it.

8. In bringing this fact into view, in connection with the practical manipulation of the precious metals in coinage, it is to be observed, that the only case in which a real practical loss could be the unavoidable accompaniment of any process, would be that in which the particles were either dissipated in such a manner that they were carried out of the premises, and could not be collected again, (although they still existed) or they might be mixed up and confounded with so large a mass of heterogenous matter, as to make it inexpedient, as a matter of economy, to extricate them. There is no opportunity for the first of these accidents to take place, there not being the smallest tendency whatever to dissipation of the metal in any one of the processes of coinage, except that of melting, and in that, as will be seen hereafter, no such thing occurs. In regard to the second, although it might be the occasion of a tri-

* The Queen's Assay Master in the Royal Mint could not have intended to be understood *literally* when he said, (Report on Mint, Art. 704) "but you may destroy gold or silver if the object be to destroy," as there is, in truth, no such thing as destruction by any created power. He doubtless meant that you might cause gold or silver to cease to be metals, in which sense they might be said to be destroyed; but this would be very different from annihilation; for whatever might be the nature of the substances into which the metals might be changed, there is no doubt but they could be easily restored to their original condition.

fling waste practically,* yet it is *not* one, in the sense in which we are now considering it; because, whether the particles so mixed up with other matter, be or be not actually separated again, they are invariably estimated in value, and allowance made for them; and it is a loss *over and above this*, supposed to be unavoidable, which I am now considering.

9. Before we proceed, let us for a moment pause and consider the above truths once more. We have established that, 1st. It is impossible for the precious metal entrusted to a Mint to be annihilated. 2d. That it is subject to no process by which it is irrecoverably dissipated,—and 3d. That even in respect to the trifling quantity which may be permitted to remain in the mass of refuse and dross, no part of the loss in question is sustained. There is, therefore, in these considerations nothing whatever to explain the large waste to be accounted for. It cannot therefore be wondered, that it should have appeared to me incomprehensible.

10. There is also another principle which is of great importance in viewing this subject; and which, had it been applied as early as its truth was admitted, would long ago have removed the difficulties of it. This is, that all the manipulation in the world, and all the processes imaginable cannot alter the *value* of precious metal. It may be melted, laminated, pickled, stamped; it may have baser metal mixed with, or taken from it. It may be alligated, or refined, and its weight may be either increased, or diminished, by the addition or subtraction of alloy; but be the processes many or few, provided the original particles still remain, and have not been abstracted or dissipated in any way, the original value is still unaltered.

11. Coupling then this fact, with those given above, a clear apprehension will be formed of the difficulty which I felt at the outset of my experience, founded upon principles which my subsequent opportunities of investigating the subject have only confirmed. Seeing that there was no process by which silver or gold could be

* In the Madras Mint the value of the silver which is contained in the refuse at an annual settlement would not amount to more than 3 or 400 Rupees; the whole value of the silver coined during the same period being 40 or 50 lacs of Rupees.

lost or dissipated, and remembering that all the operations of the coinage could not change the true value of metal once delivered to the Mint, I was naturally at a loss to comprehend how it was possible there could be an "unavoidable waste" in coining, and still less, how it could possibly amount to the large sums commonly experienced and charged in Mint accounts.

12. The full investigation which it has been in my power to make into this important subject, has fully satisfied me of the truth of the proposition stated at the outset of this paper, though it is at the same time equally certain that all the wastages recorded in the experiments referred to above, and allowed in the practices of the different Mints are by no means illusory. The explanation is to be found in the fact, that the wastages referred to are merely apparent, and apply simply to changes of the *weight* of the metal under manipulation, which are not necessarily alterations of its value, but which have been unavoidably treated as if they did involve that change, in consequence of the Mint accounts not being competent to make the proper compensations in fineness, which always accompany the losses of weight—owing to the absence of any means of detecting variations so minute as those which follow the different stages in the manufacture of coins. For want of this, it has been impossible ever to adjust the value of the out-turn of the Mint to the true standard it was supposed to conform to, and whenever very large losses have been experienced, this has most probably been one of the causes which have occasioned them.

13. A like difficulty also, regarding the precise estimation of the value of bullion on receipt, has sometimes led to its being over-rated, and unduly paid for; and these two causes together constitute, I have no doubt, the chief reasons of the waste in every Mint; the losses which have been sustained being the result, either of the bullion being over-paid for in the first instance, or being over-issued, in coins exceeding standard fineness, in the second, or by both these together.

14. It may perhaps be most satisfactory that I should in this place go through a detail of each successive operation of the manufacture of coins, and show the change which takes place in

the metal, and the causes which are apt to give rise to real and apparent loss; to state the precautions which are necessary to guard against the former, and the means by which the compensation naturally arising from the increased fineness of the metal may be made to neutralize the latter; as I think I shall then be able to show more practically than by any mere general statements, how the truths which I advance may be verified; and reconcile the conclusions which I have drawn with the more obvious and plain realities of every day's experience which have been hitherto acted upon.

15. There are no less than seven principal operations in the manufacture of silver coins, (to which I shall confine myself,) and these have their subdivisions. They are First. Melting—Second. Laminating—Third. Cutting, sorting, and adjusting—Fourth. Milling or marking—Fifth. Annealing—Sixth. Cleaning—Seventh. Stamping.

16. *Melting.*—There is a greater probability in this process, that a real loss, an actual diminution of value should occur, than in any other. I have above stated that a change of value cannot possibly be effected, except by a literal abstraction of the precious metal, and we can easily understand why such is the case. If a pound of *pure* silver, for instance, were melted a thousand times, and if copper were added to and subtracted from it by successive portions. At every step of these processes, provided none of the particles of pure metal had been allowed to escape, the result of every true assay of the metal, whether in its coarse or fine condition, ought to be such as to make its value equal to that of a pound of pure silver. There is nothing in mere manipulation to alter value, unless some of the precious particles are dissipated; but we might be inclined to suspect that this might occur during fusion. It is not impossible, one would think, that silver might be volatilized, and thus the precious metal be diminished in quantity. It is certain that if an alloy be melted, its weight after fusion is considerably reduced; but it is also equally certain that, practically, not a particle of silver escapes from the furnace.

17. This being the only point on which the smallest doubt could reasonably be entertained, I have given it the most atten-

tive examination. When I was in Calcutta in January, 1842, and visited the Mint there, I made particular inquiries as to the volatilization of silver. The very idea of such a thing seemed to be considered absurd, and I was assured that no such thing as volatilization of silver had ever been experienced. It was not the custom to sweep out the chimnies, because the volatilization of silver was out of the question, but I was told that when that metal was adulterated with mercury there was a loss, and particles of the mercury might be evaporated. This is true also in regard to lead, fumes of which escape from silver very frequently. But neither of these would at all change the *value* of the mass in fusion.

18. The same question has also been practically tested at Madras—and though no such thing as sweeping the chimnies for the purpose of recovering volatilized silver had ever been heard of previously, I determined upon having it done, in order to obtain decisive evidence upon a point of so much importance. The result was, that in the chimney of a furnace which had been in constant daily use for about 15 years, and in which many crores of rupees worth of bullion must have been melted, there were collected particles of silver which altogether weighed about 70 *grains*. This experiment taken in connection with the experience of the Calcutta Mint, seems to my mind to be quite conclusive as to the fact that there is no real loss in melting, by any dissipation of the precious metal. We must, therefore, now inquire what other causes there may be for loss. A considerable quantity of metal may accidentally escape during the fusion, or be spilt in the act of pouring, which is lost for the time, either in the furnace amongst the charcoal, or dispersed over the floor of the melting-room; but as every part of the room and also the furnaces are carefully cleaned of every atom of solid matter, and the whole of this cinder, charcoal, dust, and sweepings, is ground to impalpable powder, and the silver contained in it separated by a tedious and oft repeated washing, and the searching trial by intense ignition with a flux in the blast furnace, there is but a very trifling proportion* of it which escapes recovery, and that portion does not constitute any loss, or occasion of waste in the ac-

* The value of the silver which remains in the melter's dross is usually about 100 rupees, upon a coinage of 20 lacs.

counts, its amount being estimated and an allowance made; the dross itself being sold by auction.

19. It is notorious, however, that when silver is melted for coinage, the weight after fusion is considerably less than before, even after making this recovery, and every allowance. It is admitted also that the metal undergoes refinement, and consequently that it has become purer in quality than it was. All that I wish to add is, that its value after fusion ought to be precisely equal to what it was originally, and that there is no necessary cause for wastage or loss; and this, because it is simply copper, and nothing besides copper, or base metal, which is injured by the heat, so as to be separated from the alloy and lost in the refuse, whence it is not worth while to recover it. It is owing to the absence of any means of recognizing the minute changes of fineness in the silver alloy, and the consequent adoption of a system of account independent of them, that it has been impracticable to exhibit this truth, or to take advantage of it, in the manner indispensable to avoid waste; and the attention being therefore exclusively paid to that change in the metal which alone is palpable, viz. in its weight, is one of the great causes of the real loss which I inquired into. I propose hereafter to detail the means by which this evil has been rectified; in the mean time I must invite attention to another.

20. When the Mint receives bullion, it is supposed to receive nothing but solid metal, which is charged to it according to its weight and actual fineness, but I found that these supposed conditions did not always exist, and that the bullion was not always made over to the Mint in the solid state. In some cases coins were received, which were always more or less dirty, and these were calculated in the accounts by multiplying the gross weight of dirt and silver by the average fineness of a sample melted for assay. The consequence manifestly was an unavoidable loss, corresponding with the amount of dirt which had been reckoned as silver, and the remedy was plain, viz. taking care to melt the coins always in future. In this way one of the principal causes of the previous loss was got rid of.

21. I am not aware of any other cause of waste which attaches

to the operation of melting, taken *per se*, because, when the out-turn is correctly estimated according to its actual weight and true fineness, the result always is equal in value to that of the metal put into the pot. This has been fully confirmed on the large scale by the experience of all the operations of the Madras Mint of late years; which indeed have proved, not only that the melter's delivery may be to the full amount of the value charged against him, but even to a trifle more, owing to a cause which will be explained in the sequel.

22. But in order to make the comparison strictly, it is necessary that the melter's deliveries should be exactly assayed. It was formerly customary to allow all the ingots which were delivered within the acknowledged "remedy" to be passed into work indiscriminately, and to be reckoned in the accounts at what they were called "Standard"—but this involves a great uncertainty in the value of metal received from him. All the melter's ingots might for instance range in close proximity to the higher limit allowed by the remedy, viz. B. 1 dwt. or they might all touch the lower prescribed boundary viz. W. 1 dwt., but in neither case would any difference be shown by the accounts. In order to an accurate comparison, it is essentially necessary that the ingots should be assayed and reported at the nearest half dwt. to their true fineness, and that the melter be credited at the same, which is now invariably done in this Mint—and it is a system which not only carries with it the assurance of a strict conformity with truth and exactness, but also possesses this capital advantage, that a total check is put to the acquisition of any benefit whatever by fraudulent debasement of the metal. When all that passes out of the melter's hands is carried to account at its true weight and fineness, it ceases to be his interest to take any steps to adulterate the mixture; whereas upon the former system, when all the ingots which were not so bad but that the Assay Master might pronounce them standard, were passed into work, and credited in his account at the same value as those which were of the finest acceptable quality, it was evidently to his advantage that as few of the latter and as many of the former should be delivered as possible.

23. By the system of rating all the melter's deliveries at their

precise worth, his honesty is placed beyond suspicion, because he has no interest in being otherwise. When the Mint Master knows that whatever is taken from the melter will be rated at its true value, he may be perfectly indifferent as to any danger of adulteration. The melter can by no process whatever change the value of the bullion in his possession, and he is called upon to re-deliver all that is entrusted to him, or pay for it. There ceases therefore to be any necessity for that complicated system of watching and supervision, which however ineffectual to check fraud, when there is no other preventive, must unavoidably have been resorted to were the above simple method of checking the accounts not discovered. As I have above not only shown that there is no real cause for waste in this department, but also stated the fact that no such thing is practically experienced, it is unnecessary to dwell longer upon it, I will therefore proceed to the next.

24. *Laminating.*—In this department the experience of all Mints seems to be the same, viz. that no loss whatever is experienced. In fact, there is no part of the process by which any waste could be accounted for, excepting it were by the removal of the oxide of copper which forms on the surface of the straps while annealing, which last process is performed two or three times during lamination. I observe, by the notice of a late lecture given by Mr. Brande on the business of the Mint, that in the London Mint the annealing of the ingots is done out of the contact of the air, whereby the burning of the alloy is prevented. In other Mints, where this is not the case, the annealing would give rise to a small gain or loss, according as the oxide of copper is removed from the straps before delivery, or not. If allowed to remain, there would be a certain increase of weight; if removed, a certain diminution, but in neither any alteration of *value*. And in both these cases, the effect produced is an anticipation of those due to the subsequent processes of annealing and balancing, to which it must be referred; because, if there have been a gain in this department, it is merely at the expense of an increased, and if there has been a loss, of a diminished waste by the effect of the acid in blanching the pieces; which last apparent waste will be accounted for, and the compensation explained, when we arrive at that process. As regards the process of lamination, however, the value of

the metal is unchanged. No silver is dissipated, and if any particles are separated, they are collected together and restored.

25. *Cutting.*—In Madras, the cutting and adjusting are included in the same department with the laminating, there is no separate receipt and delivery. There is, however, obviously nothing in the process of cutting to alter the value of metal; nor can we imagine any reason why a riband of standard silver, after being cut into a million of pieces, should not be the same value as before. The experience of different Mints varies as to the occurrence of a trifling increase or diminution of weight, that is apparent value, owing to the blanks being received and delivered with a greater or less quantity of oil adhering to them; but the circumstances giving rise to this increase or diminution have no interest whatever in connection with the value of the metal, which obviously cannot be affected in the slightest degree by the greater or less quantity of oil or grease attached to it. I am not aware of any other cause which can even effect any apparent change in its value. Small particles of metal are apt to be detached by the operation of the cutters, but these are of course collected together and delivered.

26. *Adjusting.*—After the pieces have been cut, they require to be separately weighed, and adjusted to the correct standard, or brought within the prescribed remedy. The correction is made at Madras by a second cutting, and as there is evidently nothing in the mere operation of weighing to alter value, the remarks above given as to the effects of cutting, apply equally to the adjustment, the pieces undergoing no other operation whatever. In most other Mints, the adjustment is done by the use of a file, and a trifling apparent waste ensues, which Mr. Prinsep states to be chiefly due to the wiping off a portion of the oil previously gained. In so far as it is the effect of this, it is of course of no interest in our present inquiry. We may, however, perceive in the use of the file, one very trifling opening for an alteration in the value of the metal, by the removal of the particles separated from it, which might to a very minute extent, adhere imperceptibly to the persons of the men employed, and thus be irrecoverably carried off the premises; and that such a loss does

in fact take place we cannot doubt, though it is probably undeserving of the slightest notice. In Mr. Prinsep's report above referred to, the whole apparent loss, chiefly attributable to the wiping off of oil, is stated to be at the rate of only about ·0001, or ½ pie per cent. That part of it, therefore, which is due to the dispersion of the minute particles of the metal must be very insignificant. As it will be seen hereafter that this is the only opening whereby there seems to be any possibility for loss at all, it is necessary to be particular in pointing attention to the amount of it; and to add, that whether it were more or less, it is not "*unavoidable,*" as the Madras process of adjustment is unattended by any waste. If, therefore, the use of the file should be attended by a loss which is worthy of any consideration, it ought to be abandoned, and the Madras method, which is also much cheaper, substituted for it.

27. I must not omit now to state, what I have been obliged to defer to this opportunity, in consequence of the three processes of laminating, cutting, and adjusting, being associated together in the Madras Mint, that as a matter of experience, no loss has ever been met with in any of them. It is, however, necessary to add, that until within the last year, the results were not tested with so much minute accuracy as they have been since the year 1844, in consequence of my attention being occupied with other points of importance, and the apparent results previously obtained being so satisfactory, that there seemed to be no reason whatever for investigation. Up to the date mentioned, there was always a considerable *excess* in the out-turn of the three processes, which without any minute inquiry was attributed to the grease adhering to the blanks and scissel. During the last settlement, however, I adopted the plan, in imitation of the system followed in Bombay, of making a daily trial of the exact proportion of weight due to the grease, by boiling a bag of blanks in a strong solution of caustic potash, and the difference of weight shown after drying, was deducted from all the deliveries both of coin and scissel, which were entered in the accounts only at the net weight of clean metal. The last half years settlement, which has been conducted entirely on this plan, has still been favorable, and there has been no deficiency, but even a trifling apparent excess, due in my opinion to our having, in spite of all our care, somewhat underrated the grease.

28. *Milling.*—The operation of milling is merely the raising up of the outer edge of the blank, by squeezing it between two dies, to make the rim smooth. The serrated edge of the coin is afterwards formed in stamping. In this operation it will be evident that there can be no change in the value of the metal. There is nothing whatever in the use of the machine, or in the result of the process to effect any change at all. In some Mints, where a large quantity of oil is used in milling, and this is afterwards cleaned off, together with all that previously adhered to the blanks, there is an apparent loss arising from a diminution of the gross weight, by the removal of the oil which adhered to the pieces on receipt; but in this, as in the previous processes, the change is merely an apparent one, there being, as before stated, nothing whatever in the increase or diminution of weight arising from oil, to affect the value of the metal in the slightest degree.

29. *Annealing.*—The process of annealing is for the purpose of softening the blanks, and making them more fit to receive the impression of the die. It also assists the operation of the acid in cleaning. The blanks are placed in a reverberatory furnace and brought to a red heat, after which they are cooled, either by immersion in water, or by exposure to the air. The effect of this process is a slight increase of weight, owing to the combination of oxygen with the alloy in the metal; and as it is entirely superficial, it varies in its proportion according to the form and superficial area of the pieces exposed to its action. We have not made any experiments with minute accuracy on this point, as the pieces after leaving the laminating and adjusting department are counted on transfer, and thus passed from hand to hand by tale, so that trifling variations in the gross weight cease to be of any importance; but from the experiments which we have made, the difference of weight in Rupees has been shown to be about 3 annas $7\frac{1}{8}$ pie per mille, or $4\frac{1}{3}$ pie per cent. As this increase of weight is occasioned merely by the addition of a foreign substance (oxygen) to the metal, it cannot of course, by any possibility, be the cause of any loss of value.

30. It will place the subject in the clearest light, however, if we view the results of this process and the next in conjunction, as respects the alteration of weight. I will therefore merely add on

the subject of annealing, that in consequence of the effects of this and the subsequent process being entirely superficial, the apparent results are also greater in the small coins, in which the superficies bears so much larger a proportion to their weight than it does in the larger pieces. The explanation which will be given, however, showing the unchangeableness of their value, is equally applicable to them as to the rupee pieces, to which latter I only confine myself now, for the sake of perspicuity.

31. *Blanching.*—The pieces which have been blackened by the action of the fire, giving rise to the oxidation of the copper alloy, are boiled in diluted sulphuric acid, by which the whole of the oxide of copper is removed, and they are brought to the beautiful frosted dead white appearance witnessed upon articles of plate and jewellery. The acid thus carries off not only the oxygen to which the increase of weight brought about by annealing is due, but with it the copper also; there is, therefore, a net loss of weight after the action of the acid, in consequence of the removal of a portion of the copper alloy, and the result of the most accurate experiments we have been able to make upon this point, taken in connection with the results of the actual deliveries upon the large scale to and from the department, show that it amounts upon an average to about 6½ annas per mille, or 7.8 pie per cent. I should mention, to avoid mistake, that this refers to a comparison between the weight of pieces free from all grease and oil, (that is, in the condition in which they are received from the laminating and adjusting department, a deduction having been made, as above stated, to compensate for oil) and the same pieces when thoroughly clean and dry, and ready for delivery at the stamping presses. I mention it more particularly, because I have reason to believe that it varies from the experience of other Mints. Of course the 6½ annas loss is in addition to the loss of whatever increase of weight is effected by annealing, which indeed is rarely attended to, except as a matter of experiment, all the departments of milling, annealing, cleaning, and stamping, being associated together.

32. We have in Madras another process of cleaning which is peculiar to this Mint, whereby the frosting or bloom occasioned by the action of the acid is removed, and the pieces are slightly

polished. The object of this is to enable them to take a better impression in Stamping, the Madras presses not having the circular movement, and to prevent the clogging of the dies; and it is effected by enclosing them in a barrel with paddy-husk and water, and causing it to revolve for about an hour, at the end of which time they are sufficiently clean for use. This process is attended with an apparent loss of about 3¼ annas per mille, or nearly 4 pie per cent; but as it consists almost wholly of silver, it is recovered from the contents of the barrel, and there is no final waste or difference of value. In the above statement this process is included in the result of actual practice, showing an apparent diminution of weight of 6½ annas per mille upon the whole three processes; but as I believe the "churning" process is not the occasion of any part of this, owing to the completeness of the recovery, that statement will be equally true as applied to the remaining two processes.

33. The difference of weight of 6½ annas above mentioned is solely a loss of the oxide of *copper*, for diluted sulphuric acid has very little solvent power on metallic silver. At all events, it is the only diminution of weight which ought to be allowed, because if there should be any solution of *silver* by the action of the acid, it ought to be recovered, by any one of the simple and easy processes for effecting that object, such as the use of copper sheets, solution of salt, &c. If, therefore, the diminution be wholly a loss of *copper*, there has been no change in the intrinsic value of the pieces; their fineness must necessarily have increased, just in proportion as their weight has been diminished. There is, therefore, no occasion whatever for loss, as relates to value, even in this process—any more than in those which have preceded it.

34. *Stamping.*—Before going further to dispose of the apparent loss of 6½ annas per mille above mentioned, it may be as well to say a few words about the last and finishing process in the manufacture of the coin, the Stamping. It is obvious, from the nature of this process, as in respect to one or two others preceding it, that there is nothing whatever in it to alter the value of the metal; and in the exact experiments recorded by Mr. Prinsep, no change whatever was shown. In the Madras Mint, this department being associated with the three last, no separate account

has been taken, but we have every reason to concur in the result above quoted; and in the delivery of finished coins, the difference in weight of 6½ annas per mille, which has been mentioned as the result of annealing and blanching, includes every thing up to the final delivery of the finished coins. In disposing, therefore, of that apparent loss of 6½ annas, we account for every change to which the metal is subject, after its delivery from the laminating and adjusting departments; and, seeing that there is no loss whatever there, for every chance of waste subsequent to the delivery of the metal in ingots by the melter.

35. I have before shown how the mere fusion of the bullion cannot alter its value; and besides have stated, not only that it ought not, but that it does not effect the smallest change. That when proper precautions are taken, the true value of the ingots is fully equal to the value debited against the Mint for bullion, (and even more,) and that it has been proved to be so, as a matter of fact, ever since the recommencement of this Mint. As the bullion is converted into standard metal without loss, so it passes through all the other processes, except the annealing and blanching, wherein it has been stated to be subject to a diminution of weight of about 6½ annas per mille, or 7.8 pie per cent. The produce of the Mint might therefore be delivered without any waste or deficiency, were it not for this apparent loss by diminution of weight. I have, however explained, that as it is a loss exclusively of copper, the real value of the pieces is unchanged; the only difficulty is to devise a plan whereby, in spite of the imperfection of the science of assaying, the refinement occasioned by this abstraction of copper may be clearly and exactly shown, and a practical method adopted for the purpose of meeting it, in such a manner that the fineness of the resulting coins may be as nearly as possible *precisely* "Standard."

36. According to the practice of most Mints, the coins on being examined by the pyx, are reported to be "Standard," if within certain limits either way. The precise deviation which is to be allowed is, I believe, left more or less to the discretion of the Assay Master, when this system is followed; but the ordinary and proper limits are such, that they leave the value of the

delivery uncertain to a most material extent, amounting to very nearly 7 per mille. I here allude to the uncertainty which must exist, from the impossibility of judging according to such a system, as to the true value of the delivery, when it is not known whether it is all of the highest or of the lowest allowable fineness. It is not probable that it would ever be universally either one or the other, but when the distance between the two extremes is so great as that above stated, a difference, which in the coinage of a large Mint like that of Calcutta, amounting as it does sometimes to three crores per annum, would make it *possible* that the value of the delivery might vary upwards of *two lacs of rupees*, it would be vain to expect any thing like an exact appreciation of its out-turn, and hopeless to attempt to show its uniform consistency in value within such narrow limits as those marked by the changes of fineness occasioned by the use of acid in blanching the coins.

37. But that this may be done by a different system I shall proceed to explain; and it is remarkable, as well as fortunate, that the difference in practice which is essential to success is so very trifling. All that is necessary is, that in regard to the assay of coins as well as ingots, the report should be made to tell the exact fineness to the nearest half pennyweight, like the assay report of bullion, according to some invariable plan. It is not very material what the system of report is, but it should be followed with the most undeviating uniformity; and if so, an application of the actual average of all the assays of the coins (the more numerous the better) to their weight, will show their true value with very great precision; and if in addition to this, an uniform system of valuing the bullion received by the Mint be also rigidly adhered to, it is possible not only to make an exact valuation of the out-turn, but to show very distinctly even the compensation for the apparent difference of value occasioned by the loss of weight in blanching.

38. I shall first proceed to give an example of the method by which the whole out-turn of the Mint is valued, and then show how the comparison between that value and the value of the blanks before blanching clearly indicates the refinement by the process.

Let us suppose then, that the out-turn of the Mint has been 40

lacs of rupee pieces, and that there have been 500 assays made of them, of which the results were reported to be as follows.

B 1	B ½	Standard	W ½	W 1
5	40	320	135	0

39. In order to find the exact value by means of the above scale, we must remember that, if such a case should occur, (though it rarely does in Madras) every piece varying a full pennyweight from "Standard" is to be reckoned as equal to two varying only ½ dwt. and therefore, in striking the balance in the above example, in order to find the average, we have to set off 50 on the "better" side, against 135 on the "worse," and the case then stands.

B ½	Standard	W ½.
50	320	135

Now by cancelling 50 on each side, and supposing that, as the deviations of fineness compensate for one another (in value,) they may be reckoned as "Standard" coins, and joined with them accordingly; there remains a surplus of 85 W ½ pieces out of the original 500, showing that $\frac{85}{500}$ths of the whole delivery, or 17 per cent were a half pennyweight below "Standard." Taking therefore $\frac{17}{100}$ths of the 40 lacs of pieces, and reckoning the difference between the worth of these had they been full "Standard," and what they are worth when only of the fineness of W ½ dwt., we find the deduction to be rupees 1545–7–3¼, and subtracting this from the 40 lacs of rupees, the remaining true value of the whole delivery is 39,98,454–8–8¾.

40. The above process, simple as it is, furnishes an exact measure of the value of the out-turn of the Mint, and I have reason to believe that the result may be depended upon to considerable nicety, spite of any accidental errors in the assays upon which it is founded, which if there be no systematic cause of inaccuracy, compensate one another. It also supplies a distinct criterion, whereby to judge of the conformity of the coins with the Standard prescribed by law. This will be best illustrated by the last example. It was seen that in the imaginary case there stated, 17 per cent were found to be W ½ dwt., the rest being Standard. This

is the same, in effect, as if the whole 40 lacs were $\frac{17}{100}$ths of half a pennyweight below Standard. And therefore W $\frac{17}{200}$th dwt. or about W $\frac{1}{12}$ dwt. represents the true deviation of the whole coinage.

41. The same result would be equally shown, were we to arrive at the fraction, by comparing the deduction made for worseness with the gross weight, but we must remember in doing so, that $\frac{17}{200}$ths of a dwt. is $\frac{17}{200}$ths of $\frac{1}{220}$th; or $\frac{1}{2588}$th of the whole value, which agrees with the proportion of

$$\frac{1545 \text{ ,, } 7 \text{ ,, } 3\frac{1}{4}}{40 \quad 00 \quad 000.}$$

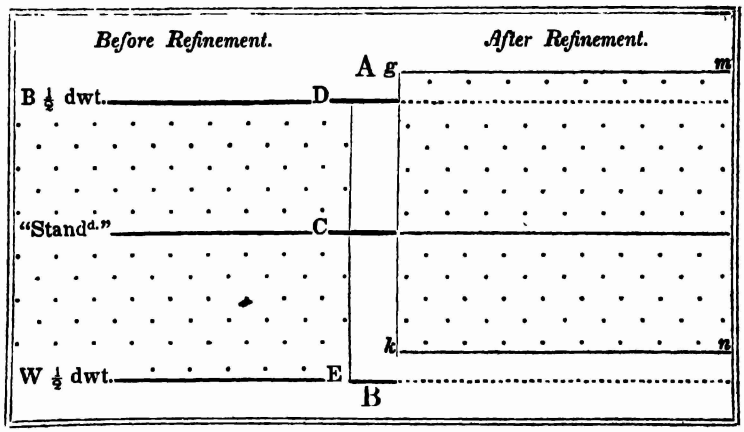
42. In order to make a strict comparison of the receipts and issues of a Mint it is absolutely necessary to calculate the value of the out-turn in this or some other equally exact manner. It is impossible to attain any thing like exactness, when the value of the out-turn is subject to an uncertainty so great, that in the transactions of a large Mint the true worth of the delivery might exceed or fall short of the nominal value assigned to it by a lac of rupees either way, in an extreme case, without its affecting the accounts. Even in the comparatively small operations of this Mint, the uncertainty might easily reach to 10 or 15,000 rupees either way in a year's transactions. And that system must be obviously incomplete, which at the same time that deviations in the gross *weight* of the out-turn are accounted for to the nearest *anna*, leaves thousands of rupees worth of value in the fineness wholly unregarded.

43. In order to understand clearly how the compensation for the loss of weight in blanching the coins is effected by the increased fineness, it is necessary to enter into some explanation. It might at first seem to be impossible, that a change of fineness which, in rupee pieces, does not probably exceed the $\frac{1}{8}$th part of a pennyweight, could be shown by an assay which is unavoidably attended by some uncertainty in its results, and which consequently does not profess to mark changes of smaller amount than four or five times that magnitude; but if we take all the circumstances into consideration, we shall see that the difficulty is not so great

as might be imagined, and we shall be able clearly to trace the mode of its solution.

44. Bullion passed into work is, in Madras, invariably such as has been reported either "Standard" or W $\frac{1}{2}$ dwt., but in consequence of the unavoidable uncertainties in the assay, above alluded to, it is by no means sure what the *exact* fineness of metal reported under either denomination may be. To confine our view for the sake of perspicuity to one description only, the designation "Standard" includes all finenesses of metal between B $\frac{1}{2}$ dwt. and W $\frac{1}{2}$ dwt., so that out of every thousand ingots reported of that fineness, many may be expected to be, or appear to be, very nearly B $\frac{1}{2}$ dwt., many very nearly W $\frac{1}{2}$ dwt. Now the effect of the acid, in removing a part of the copper, is to exalt the purity of the whole by a trifle, as above stated, about the $\frac{1}{4}$th part of the $\frac{1}{2}$ dwt., and the result of the next examination of fineness by assay would be, that out of the whole thousand, all those whose apparent fineness had previously been any thing superior to $\frac{3}{4}$ths of $\frac{1}{2}$ dwt. Br. would now be so raised in purity as to be reported B $\frac{1}{2}$ dwt.; and this proportion of the whole would be more or less, the greater or less the actual refinement had been.

45. Perhaps this matter may be made more plain by reference to the subjoined diagram. Let A B be taken to represent a scale of the real fineness of metal, of which the point C represents the "Standard" degree of purity, E the degree next below it, or W $\frac{1}{2}$ dwt. and D the next above, or B $\frac{1}{2}$ dwt. Let us suppose also that the numerous dots on the left hand side of A B represent the positions on this scale which a number of coins about to be blanched occupy, according to the fineness shown by assay as belonging to the metal from which they were cut. We must recollect that all which fall between D and E are reported "Standard," but all which rise in the smallest degree above D, are reported B $\frac{1}{2}$ dwt. After the refinement which has been effected by the acid, the position of all the marks on the scale is raised as shown by the lines g m, k n, and by this means the whole of the marks which were highest on the scale, before the rise in their purity took place, are now above the mark D, and are therefore reported at the next higher fineness.



46. Just also as a part of those blanks which were previously reported "Standard" are by the operation of the acid in the blanching raised to the fineness of B ½ dwt., so are part of the rest, which were previously reported of the fineness W ½ dwt., raised to the degree "Standard." These changes of course affect the average fineness of the whole mass of coins, and our experience shows that it does so to such an extent as to compensate for the loss of apparent weight; and the precision with which the effect of even small changes of fineness upon the value of large masses of coins may be shown by assaying, a process so uncertain in *individual* cases, may be considered very remarkable by those who have not been in the habit of viewing its results in this manner. By way of illustration, I shall here give an example taken from the actual practice of the Madras Mint.

47. During the seventh half-yearly settlement, viz. from November 1845, to April 1847, the gross weight of the pieces passed into the cleaning (or blanching) room, was 11,60,088 Tolas, and their real Standard value, as calculated by rating those pieces only at full Standard which were cut from Standard ingots, and those at the fineness W ½ dwt. which were cut from straps of that denomination, amounted to 11,59,581 rupees—being 507 rupees less. After the coins had been cleaned, the assays upon the pyx samples of all the finished coins were in accordance with the following abstract.

	B ½	Stand.	W ½
9,90,950 Single Rupees, - -	7	71	5
3,92,000 Quarter Rupees, - .	2	28	1
5,64,570 Double Annas, - -	6	63	2

48. Making the calculation in the manner before explained, it appears that the whole of these coins were on the average above standard; the rupees to the extent of about 54¼ rupees in value, the quarter rupees by 7 rupees, and the two anna pieces by 9 rupees. Total of all three, 70¼ rupees. It thus appears that the whole mass of coins, which before cleaning was 507 rupees below standard in fineness, was after it 70 rupees above, being an increase of 577 rupees; but the weight had been diminished by the process 483 tolas, so that the value of the 11½ lacs of rupees worth of coins remained 11,59,675 rupees, being within less than 100 rupees, the same as before, rather more than a full compensation having taken place.

49. A difference even greater than this would not very materially affect the evidence which may be drawn from the above example, as to the compensation which takes place in fineness for the loss of weight in cleaning coins, and I am of opinion, that were the assays more numerous, and the operations upon a larger scale, the accordance would be more close. I have only to add upon this part of the subject, that the experience of the Mint since 1841 fully confirms the view above taken, although in consequence of our having neglected to take into accurate consideration the effect of grease upon the blanks and scissel, the accordance cannot be so distinctly shown in the former as in the later settlements. In all, however, the effects of the refinement are abundantly plain, and in only one instance out of seven does it fall materially short of a full compensation, the difference in that case being occasioned by a known cause, distinct from any circumstances affecting the question now under consideration.

50. I shall have occasion very shortly to state other facts which will make it evident that any trifling discrepancy, plus or minus, is of immaterial consequence in the accounts of a Mint. In the mean time, I trust, that it will be quite plain, both from the

above reasoning, and from the experience which I have stated, that there is no cause for deficiency, even in the apparent waste attending the blanching of coins. It is necessary now to pass on, and show how the real waste, when it does take place in a Mint, is experienced; and how, in connection with the system of which a part has been above described, this source of deficiency may be obviated.

51. It has been already remarked, that when no means exist for the precise valuation of the out-turn of the Mint, it is impossible to secure an exact correspondence between its nominal and real value; and that by attention to mere weight alone, the most important element in the calculation is neglected. We have also seen, that throughout the whole of the processes there is none that necessary alters the *value* of the bullion, so that if the same be correctly calculated on receipt as well as issue, no material difference ought to be found. It might be sufficient, therefore, for a comparison of the Mint accounts, that the true bullion values of its receipts and issues should be taken; but something more is necessary if it be required, not merely that the department should fully acquit itself of the trust reposed in it, but that the State should suffer no loss. In order to effect this, it is essential that the true bullion worth of the coins should be closely adjusted to the "Standard," and that their nominal and real values should be equal to one another; so that the Mint establishment should not, in consequence of the coins being finer than they ought to be, take credit for more than the State actually receives the benefit of.

52. This may be done with the utmost precision, according to the practice partly described above, and that with great simplicity. Nothing more is necessary than to attend to the results of the operation of cleaning, and the consequent out-turn of the finished coins, and to regulate the proportion of the different kinds of ingots passed into work accordingly. It has been above stated, that only two kinds of ingots are ever taken from the melter, viz. "Standard" and W ½ dwt., and the reason of that will now be obvious. As the effect of the refinement in cleaning is to exalt the title of some of the pieces, it would neces-

sarily follow, that if no metal but that which was reported "Standard" were taken, the out-turn would be composed of "Standard" and B ½ dwt. coins only, and consequently would, taking the average "en masse," be above "Standard." In order to balance these, there should be an equal number of pieces equally below "Standard," that is W ½ dwt., and it must be remembered that part of these also might be raised to the denomination "Standard." All that is necessary, therefore, is to observe what relative proportion of these two denominations will, after the various refinements occasioned by manipulation, yield about an equal number of B ½ dwt. and W ½ dwt. coins, and to take that proportion of "Standard" and W ½ dwt. ingots only from the melter, regulating his practice, as to the addition of alloy,* in such a manner that it shall uniformly turn out the proper ratio. As the process of assaying is more accurate in regard to finenesses near to "Standard" than any other, and as the practice of the melting department is exclusively directed to the production of that, the prescribed quality of metal, it very rarely, if ever, happens that the pieces exceed the ½ dwt. either way, an accident which could only occur in consequence of an erroneous character having been attached to some of the ingots passed into work.

53. Indeed, if it be assumed that the assay reports are correctly made, it is evidently impossible that there can be any wide deviation in fineness at all; for as all the processes of manipulation tend to exalt the purity, and the only pieces varying from standard are those whose title is the *nearest* degree below it, it follows that all the changes which the latter undergo, tend to bring them nearer to perfection, and when the adjustment is made in the manner above pointed out, the result is in as close accordance with the "Standard" as it is possible to be brought by any means, as long as the assay remedy, or limit of uncertainty, remains a ½ dwt.†

* There is no danger whatever of the melter's going too far, or disobeying orders, for as explained in paras 10 and 23, no addition of alloy whatever could add to the *true value* of his deliveries; and as he is credited at that rate, and that only, his attempting to debase the metal would gain him no advantage, and on the contrary would lead to punishment for too great departure from "Standard."

† Greater accuracy might be attained in coinage, and much benefit would

Thus the coins on being examined by the pyx, show a large majority true "Standard," and of the rest about an equal number above and below it; and the nominal and real values of the pieces correspond almost exactly. In this case, the compensation for the refinement and loss of weight in blanching is gained by the difference between the gross and standard weight of the ingots taken from the melter; for as part of them are of the fineness of W ½ dwt., and the whole of the rest "Standard," it follows that the gross weight of the pieces cut from them exceeds their true "Standard" weight, at which last only the melter is credited, although he delivers without loss. On the final delivery by the Mint, however, the fineness of all the coins, on the average, has become true "Standard," and therefore the standard weight has become equal to the gross; the difference which previously existed having been occasioned by the excess of copper which was removed by the acid,

ensue from the universal adoption in the Indian Mints of the decimal system of reporting the fineness of metal, that is reporting the "touch," as has long been practised in regard to gold. By referring to the division of the pound troy into pennyweights and half-pennyweights, the Assayer now reports to the $\frac{1}{480}$th part, and it is intended that his reports should be uniformly accurate to that extent; but if a decimal notation were used, and the precise result were noted to the third place of decimals, or the $\frac{1}{1000}$th part, it is not probable that the deviations would exceed their present magnitude, and the precision with which the duties of the Mint could be conducted, even admitting errors to exist to as great an extent as at present, would be much increased. But besides this reason, it is abundantly desirable that something simpler than the complicated phraseology of ancient times should, in these days of enlightenment be introduced, were it only for the purpose of facilitating the labours of the Officers of Mint Committees, and in part clearing up the deep mist of obscurity in which all Mint questions are involved, and that chiefly by the use of these very terms of Assay. They were probably invented when the simple act of assaying was wrapped in profound mystery, and they certainly are well calculated to keep it so; but in the service of Government, and especially in this country, where every public Officer has too much real business to attend to, to have time to spare for mystical research, it is most desirable that as little needless obscurity should be allowed as possible. It really takes a great length of time to become thoroughly familiar with the terms B 14½ dwts. and W 3 car. 3¾ gr., so as at once to attach distinct meaning to them, but the corresponding terms of the decimal system, viz. 97¾ per cent of pure silver, and 75¼ per cent of pure gold, are instantly and clearly intelligible to any one. It may, therefore, be easily perceived how great a stumbling-block in the way of the comprehension of Mint papers would be at once removed, if the simple expedient of the decimal notation for assays were adopted.

an operation which occasioned an apparent loss, though the standard weight was unaltered.

54. Having now, as I trust clearly, shown that there is no real necessity for any material loss by the operations of coinage, and that consequently the out-turn ought to equal the receipt, I must proceed to notice an expression made in regard to the out-turn of the melting department, and to explain how it is that no there ought to be no loss, but that even a real *surplus* of delivery, a net *excess*, will be met with upon all the operations of the Mint. The cause of this is no doubt well known, but it is remarkable that no notice of it whatever is taken by the accounts of any Indian Mint that I am aware of. In fact, it is not to be expected that whilst the accounts of the department have usually recorded only a loss, much attention should have been paid to a circumstance which clearly pointed to an opposite result, however distinctly the fact of the existence of such a cause might be acknowledged. But I have little doubt that in every Mint, if the results of its operations be tested in the manner I propose, they will not only exhibit the truth of the proposition which I have advocated, but also prove the existence of a surplus hitherto unnoticed.

55. The cause of this unrecorded surplus is the difference between the "trade assay" and the real worth of bullion. It is the universal custom of all Assayers, inasmuch as it is impossible to obtain *perfection* in accuracy, to make their reports of the fineness of bullion to such a degree of minuteness only as they can be sure of. Just as, in the mere weighing of bodies, it is impossible to do more than to state the smallest fraction which the beam will indicate, leaving the minute remainder undefined; so in registering the fineness of an alloy, the final process of which is dependent upon the scale beam, the Assayer merely notes the smallest division which his beam will indicate truly, and the minute surplus remains untold; the universal rule being that the purchaser, that is the Government, and on its behalf the Mint, is allowed the benefit of it. It thus happens that on every occasion when bullion is assayed for delivery to the Mint, there is a trifling surplus, more or less, which is not carried to account and charged against it,

and though upon each individual occasion it is quite impossible to say what the amount of this benefit is, because it is owing to the very circumstance of the impossibility of stating this fractional excess with correctness, that it is omitted; still a very little consideration will prove, that in the long run of a vast number of such transactions, the amount of gain arising from these indefinite fractions it is not only tangibly and actually realized, but is capable of accurate calculation.

56. As I am aware that a good deal of difficulty has been occasionally felt in regard to this subject, more especially in distinctly understanding how it is possible that a correct calculation can be made of the sum of a series of fractions every one of which is doubtful, I subjoin some extracts from a memorandum written in explanation of the subject, which will I hope make it more clearly intelligible.

57. "The benefit by the assay remedy arises from the custom of reporting assays by ½ dwts. only, and by never using a smaller weight. When the button which shows the proportion of pure silver in a bar is being weighed, as many ½ dwts. are put into the scale as will almost, but not quite turn it, the excess of weight being always left on the side of the button, if there be any difference. If there be no difference, then there is no benefit, but as metal is assayed of every conceivable shade of fineness, and consequently the assay buttons are of an infinite variety of weights, intermediate between the stated divisions upon which the report is made, so there is in every case, excepting when it happens to fall *exactly* upon the precise ½ dwt., a gain more or less, which is invariably given in favor of the Government. The amount of this gain is never ascertained, because it is not usual, and would take up too much time to put in fractional weights, and it would be useless to adopt the practice of doing so, because the process of cupellation is liable to errors which might cause variations, more or less in the fraction, and thus make its value when stated, incorrect. The fractional benefit is therefore always doubtful as to its precise value, but not so as to the fact of fractions in general being a decided and substantial benefit. If the merchant weighs goods by a scale which only turns with an ounce, and gives

himself invariably the benefit of the turn of the scale, it is quite certain that in the long run he must gain, although the amount of gain in each transaction is quite uncertain.

58. "In assaying, it is impossible to say with certainty what the real benefit upon any one transaction is, because the errors in cupellation are so unavoidable that it is very probable that the particular button or buttons do *not* represent the ratio of pure silver in the bar exactly; but as there is no reason why the errors should make the buttons statedly either heavier or lighter, it is certain that, in the long run, the heavy and light ones will be equally numerous; so that, as regards a large series, the accidental errors of cupellation will not affect the result, and the amount of benefit, as a whole, will be the same as if there had been no errors.

59. "But though the amount of the fraction in a single case cannot possibly be determined, that is no reason why the value of a very large series of them may not be determined with abundant precision. It is impossible to say how long any single man resident in London, of the age of 20 years, will live, but the gross total of the years of life of any very large number, say 10,000 such men, may be calculated with the greatest precision, and why? Because we have the means of ascertaining the *average* age of each man with considerable exactness. I shall now be asked to explain, how I can obtain the average value of these uncertain fractions; I answer, by the well known rules of arithmetic and laws of chance.

60. "If a man throws a single die a vast number of times, the number of marks on the uppermost face of the die at any given throw, cannot possibly be foretold, but the total number of marks which will turn up in a million of throws, may be reckoned with certainty, thus: Since there is no reason whatever why any one face should be turned up, more than any other, it is certain *in a very large series*, they will all do so about an equal number of times, and therefore, as the average number of marks on the six faces is $3\frac{1}{2}$, the total number thrown will be equal to $3\frac{1}{2}$ times, the number of throws. Again, if a million pebbles of every conceivable weight, between 1 lb. and

2 lbs. be taken, although the actual weight of each individually may be unknown, the gross weight of the whole million may be calculated very nearly. For if the difference between the 1 lb. and 2 lbs. be supposed to be divided into tenths, it may be assumed with almost certainty that, in a vast series, there will be about an equal proportion of the whole which will fall to each of these divisions; and therefore, as the average of all of the [illegible] $\frac{5}{10}$ths, the average weight of all the pebbles would be $1\frac{1}{2}$ lbs.; and the weight of the whole million, very nearly $1\frac{1}{2}$ million pounds.

61. "And so with regard to assays, if the difference between the dwt. and $\frac{1}{2}$ dwt. be supposed to be divided into ten parts, it is probable that, in a very large series, the fractions of benefit will be equally numerous on all, and the average or mean value would therefore be $\frac{5}{10}$ths or $\frac{1}{2}$ of $\frac{1}{2}$ dwt. that is $\frac{1}{4}$ dwt. which is equivalent to $1\frac{1}{8}$ per mille: but as, according to what is stated above, there are a certain number of cases in which the weight of the button may be *exactly* the $\frac{1}{2}$ dwt., in which case no benefit is gained, a deduction has to be made from the above result to allow for them, and this deduction can only be learnt by experience, because it depends chiefly on the delicacy of the beam used by the assayer, and his personal habit in weighing. But it has been stated by the Officers of the Royal Mint,* that the average benefit is about $\frac{4}{10}$ths of the complete fraction, thus making $\frac{1}{10}$th the deduction for *exact* buttons; and if that ratio be assumed in this case, the result of the benefit of all the fractions would be $\frac{4}{10}$ths of the $\frac{1}{2}$ dwt.; and since the benefit of the full $\frac{1}{2}$ dwt. is 2·27 per mille, $\frac{4}{10}$ths of that would be somewhat less than 1 per mille."

62. From this, I fear rather tedious investigation, it appears, that the average surplus which ought to be realized in every Mint which receives bullion debited against it at the "trade assay" ought to amount to nearly one rupee in every thousand. The experience of the Madras Mint has been quite in accordance with this expectation. We have not, however, always had a surplus so large;

* Vide Mr. Beckwith's evidence before the Select Committee on the Royal Mint, Art. 788.

and in the course of seven settlements, we on one occasion had none at all, being a few rupees (about 70) deficient; but circumstances occurred, which were well known at the time, to cause these results to be less favorable, and fully accounted for them in a manner which in no way interferes with the truth of the proposition advanced in this paper; and as it would be inexpedient to enter into a discussion of them in this place, I shall merely say that they have been such as are but seldom li be met with in most Mints, and that even in spite of them, the gross results of the coinage of this Mint, since the commencement of the system in 1841, have given what will, I trust, be considered sufficient evidence of the truth of my arguments to entitle them to confidence; the net excess upon the coinage of 115 lacs of value, having been, when every thing is fairly calculated, rather more than 7,000 rupees, being at the rate of $\frac{7}{12}$ths per mille.

63. The above statement shows the actual balance taken upon the whole coinage since August 1841, but if shorter periods only were examined, the comparative excess, would in some, be much greater. It is, however, not unreasonable to infer, that if all the processes of manipulation be conducted in a strictly uniform manner, and the valuation assigned to the bullion be equally so, its net produce or out-turn, would not be otherwise; and it might therefore be expected to be uniformly as favorable as we have experienced it to be in the best settlement; and I have been led to the conclusion, from the facts and reasoning above given, as well as from the improved regularity and increased produce of our later settlements, that a surplus of one per mille may be reasonably calculated upon in every Mint; an expectation, which will appear to be less unreasonable, when I remind the reader of the fact stated in evidence before the Committee of the House of Commons, that the gain arising from the same fractional difference between the "trade assay," and real value, in the coinage of gold in the Royal Mint, had actually amounted in 15 years to no less than five lacs of rupees,* or upwards of 33,000 rupees per annum.

64. It will be seen by what has been before stated, that the chief points essential to success in the adjustment of the accounts of

* Vide Report of the Select Committee on the Royal Mint, Art. 1892.

the Mint, are, 1st to take care that in the valuation of bullion received, the true weight of *solid metal* actually handed over be charged for, and nothing more; 2dly, that in the out-turn of pieces, the precise value of all the deliveries be ascertained by the average of as large a number of assays of pyx coins as possible; and 3dly, that this value be made to correspond closely with the standard and nominal rate of the pieces, by the method of adjustment described in para 52. If this be done, it is not only true that there ought to be no waste or difference between the receipts and out-turn,* but as long as the unreported fractions in assay are thrown into the scale in favor of the Government, an excess ought to be exhibited, which may be estimated at nearly one per mille. A surplus which alone would amount in the transactions of all the Indian Mints, to between 30 and 40 thousand rupees per annum.

65. But the chief use which I think may be derived from the principle which I have endeavoured to establish, is the assistance which it is in its power to render towards the establishment of a simple and efficient system of check and control over the executive operations of the Mint. Thus, in regard to the melter's accounts, when the attention is exclusively directed to the difference of *weight* only, which the metal undergoes by that process, the whole responsibility of the custody of the metal, must be necessarily dependent upon the vigilance of the watchmen who superintend the operations, and the honesty of the parties engaged in them; because it is impossible to distinguish between any deficiency which may be caused by fraud or peculation, and the uncertain but unavoidable loss (of weight) which is the result of fusion; whereas, by referring to the simple fact that the real value of metal is not changed by the fire, and that consequently, the value of the out-turn in ingots must necessarily be equal to that of the bullion melted, the check is so certain and secure, that all the expense, trouble, and responsibility of watching the proceedings of the department, may with perfect safety be dispensed with. In

* It deserves to be noticed, that suggestions were given by Mr. Prinsep with the view "to provide against any undue wastage, and yet to preserve the coin of full weight on its issue from the Mint." But these suggestions, from not asserting the principle now brought forward, did not extend to the root of the evil; and the consequence, I believe, is, that they have not been successfully carried out in practice.

Madras, the head melter gives security for the safe custody of the bullion entrusted to him, and with that precaution he cannot go wrong; for unless it were possible that there could be collusion with the Assay department, any attempt at fraud must instantly be detected. I may here mention, that he is not only expected to return the full value debited against him, but also that of the unreported fractions, alluded to in para 21.

66. And in the same manner that perfect security may be obtained by the Mint Master as to the proceedings of the melting department, without the necessity of a constant dependence upon the unrelaxing vigilance of his Superintendents, and the honesty of his workmen, so may the Officers of Government keep a strict and perfectly secure check over the operations of the whole Mint, without the smallest reference to the tedious and elaborate details which, for want of a simpler system, it is necessary to lay before them. Details, many of which are so intricate and obscure, that nothing but a long apprenticeship and familiarity with such subjects can render them intelligible. If it be once established that the out-turn of a Mint ought to be equal to its receipts, the whole mass of these details may be set aside for the single comparison between the receipt and out-turn.* I trust that I have succeeded in making it apparent that

* I hope it will not be supposed, that I would in the least degree advocate the details above mentioned being unattended to. The apparent wastages, as well as every incident peculiar to the manipulation of the bullion, must always be interesting to, and matter of the closest scrutiny by the proper Officer, the Mint Master; but I am decidedly of opinion that these matters are not only a burthensome tax upon the patience and attention of the Officers of Government, but that they absolutely frustrate the very object they are intended to bring about, by diverting inquiry from the points of real importance, and fixing it upon others which are of no moment at all, and the information regarding which is necessarily so incomplete, that the data given cease to be of any use whatever. For instance, while the apparent wastages in each room may be most closely scrutinized from time to time, and the accounts compared with one another and found to agree, they might nevertheless be altogether inaccurate and delusive, and afford no clue whatever to the proceedings of the department; trifling and unobserved alterations having been made in the manipulation, which, without intending it, might have materially affected the results; changes such as are now referred to are constantly apt to take place, from a variety of circumstances, and their influence can not be foreseen by any one, and must be wholly unknown to the Officers of Government.

not only is this the case, but that even more than this may be depended upon; and it is merely necessary to add, that the only circumstances which I am aware of, as likely to cause the least fluctuation in the amount of the fractional surplus which may be looked for, are the chance of errors in assaying, or the failure on the part of the assayer to allow all the benefits which are calculated upon.

It might be a question whether the fractional gain above alluded to ought to be taken advantage of by the Government; but perhaps when it is understood that it is the universal and well known privilege of the purchaser in all countries, the question is not likely to be raised.* If, however, it be conceded that the Government rightly has this advantage, the fact of its possessing it, offers a strong argument in favor of the Merchants being released from the charges incurred in melting their bullion, which I believe they are called upon to pay in some Mints; and the rule for the adoption of that most necessary, and in fact indispensable preliminary to any thing like a strict system of check in the Mint, might be made universal and imperative.

68. I have throughout this paper made no allusion to one, and I really believe the only one real cause of waste in Mints,

* There are reasons which make it desirable that the fractional gain should be given in the coins, either in whole or in part, and that the latter should in fact be somewhat above "Standard;" and whenever the management and practice of the Indian Mints shall be reduced to an uniform system, a measure very desirable, but requiring much care, it will be a question for discussion whether it ought not to be a matter of regulation that it should be so; the duty of the Mints at present being, of course, to adhere as closely as possible to the prescribed standard. But even if this were done to the full extent, although the Government would thereby sacrifice the trifling benefit which they would otherwise derive from the fractional excess, there would be no alteration as to the distinctness of its exhibition by the Mint accounts; for the debit and credit in the Mint books being regulated by the true value of the receipts and deliveries, could not be affected by the proportion of silver put into the coins; and if the latter were issued of a somewhat finer quality than "Standard," they would be charged in the Mint books at a rate somewhat above their nominal value, and a difference equal to the value of the unreported fractions, or such part of them as had been given in the coins, would exist between the credit allowed to the Mint by Government, and the *nominal* value of coins received from it.

worth speaking of, and that is peculation, and I have omitted it for obvious reasons. It does not come under the head of those causes of waste which are "unavoidable," but it is nevertheless serious, and requires much attention and care on the part of the executive Officers of the establishment. My object has been, rather to pave the way for the establishment of a system of check, by which the real losses by fraud and peculation might at last be discernible, and to view the subject in the [illegible] of the relation between Government and the Mint establishment, [illegible] to consider the duties of the Mint Officers in relation to their subordinates.

69. Few subjects require more constant attention than that of guarding against frauds and peculation, and there is hardly any one of the arrangements of the department [illegible] more difficult to place on a satisfactory footing, than [illegible] measures which are necessary to keep up an unintermitting and secure check against these evils, owing to the great apathy, indifference, and dishonesty of the agents who must necessarily be employed in the service. The system to which I have been gradually endeavouring to bring matters since I have been in charge of the Madras Mint, has been that of the separation of the different working departments into distinct wards, completely enclosed on all sides, and with but one entrance. A gollah, or watchman is stationed at this opening, whose duty it is to examine all who pass in and out of the ward, and he is accountable to the Superintendent of that department for the performance of the duty. Each Superintendent is separately responsible for the bullion received and delivered by his ward, so that he is in the general way accountable for the accuracy with which the search is carried on.

70. As a check upon the watchmen of the different departments, and for the security of the whole establishment, great pains are taken in the search of workmen at the great gate, or general entrance. The operation of search is twice gone through, the first time by servants of the establishment, who are promised a reward for each discovery, and threatened with dismissal in case of their passing over an attempted theft; and

the *second* search is by expectant "*oomeidwars,*"* who are stimulated not only by the promise of the same reward as is held out to the other searchers, but also by the chance of succeeding to their situations, in case of the established servants being discharged for neglect.

71. Should any piece of bullion be discovered at the great [illegible] the watchman of the department to which the man upon [illegible] it was detected belonged, would, of course, be accountable for having allowed him to pass, but no such case has yet occurred; the department gollahs have once or twice detected an attempt to secrete an old coin, but no piece of bullion or *new* coin has ever got as far as the great gate during my time. Other small coins have been frequently brought into the [illegible] ignorant parties, spite of the prohibition posted up on [illegible] ter wall against it, and these have been very often detected on their going out again, but I do not recollect any thing worse having been ever brought to my notice; and as the general out-turn of the Mint is such as to prove that there cannot be any very considerable loss in that way, I am inclined to hope that the difficulties of effecting the concealment, during a threefold examination, may be so great, and the punishment attending a discovery so alarming, as to have discouraged the attempts altogether.

72. I cannot conclude without stating one general principle which may be useful as a key to the consideration of all questions as to a real and apparent "waste." It is this; whatever the process may be which is suspected of being the cause of waste, one of two things must be true regarding it. Either it removes silver from the metal or coins, or it does not do so. If the latter, then there is clearly no change or diminution of real value, as I have explained above. If the former, then the silver may be sought for and *recovered* from the refuse. When this truth is attentively considered, it cannot, I think, fail to be perceived, that no such thing as waste, unaccounted for, ought to exist, or to be suffered in any Mint; a proposition, the truth

* Candidates for employment.

of which it has been my object to demonstrate by the facts and reasoning contained in this paper; and however feeble and imperfect my attempt may have proved to be, I trust that I may at least succeed in attracting attention to it, and that I may venture to look with full assurance for the confirmation and establishment of my views, by the researches of others better able than myself to do justice to the subject.

POSTSCRIPT.

Since the paper on this subject passed through [illegible] have been favored with the criticism of a friend, wh[illegible]ion I value most highly, based as it is upon a thorough knowledge, and long practical experience of the subject. The remarks which he has kindly made, were not written with any intention that they should be thus noticed, but as the subject is an important one, and as they state difficulties which might naturally present themselves to others as well as the writer, I have taken the liberty of entering into the explanations to which they give rise, to guard against the misconception which might otherwise exist in the minds of others. My correspondent writes thus: "I admit to the full most that you assert, but with reference to the "loss in melting, I cannot make up my mind that the quantity of "silver remaining in the dross is so small a fraction as you "suppose it to be; it could only be ascertained by some most "careful experiments; for instance, if in your assays of bullion, "any allowances are made for cupel loss, for refinage in muster "melting, &c. &c., and that estimated quantity is greater than "it really is, so much more silver has to be accounted for "from the dross. It is true that most of the silver in the "dross is recoverable, but when the quantity is very minute, it "is practically out of the question, as the expense of the process becomes greater than the value of the bullion recovered." Upon this I must explain, that my arguments as to the absence of any essential waste in coinage, are based upon the supposi-

tion that the bullion is truly and fairly debited to the department, according to the "trade assay;" in which case, as I have stated, instead of a waste by the processes, there ought necessarily to be an actual and considerable gain. If, owing to an inaccuracy in the cupel allowance, or the allowance for refinement in muster melting, more or less than what is proper should be left in the dross, then, in that case, this gain would be greater or less according to the amount of error; but it appears to me to be unadvisable to embarrass the question by the supposition of errors in the assay, which may tell either way, because the conditions under which the argument is stated exclude that supposition, and they are not affected by it.

The quantity of silver which has been stated by me to remain [illegible] at each settlement, is not a matter of inference or deduction, [illegible] is ascertained by actual experiment by the Assay Master, every separate dross belonging to each department of the Mint, being ground to impalpable powder, and after being thoroughly mixed, a sample recovered with the utmost possible care, as a specimen of the whole. It has, however, been stated, in the Memorandum, (para 62,) that while the drosses usually contained these amounts of bullion, the accounts of the department during seven settlements had been made up, and showed a considerable excess. If it were possible that the drosses contained more than was supposed, the same having escaped the scrutiny of the Assay Master, we should be forced to conclude from that circumstance, that had the recoveries been made more perfectly, a larger excess of the deliveries beyond the accounts would have been the consequence.

My friend proceeds: "Again, there is a slight irrecoverable loss "in all the Minting processes; minute particles of silver are "separated from the ingots under the rolls. In annealing, very "thin laminæ are melted, and lost in the furnace: in filing, as "in the rolling mill, some of the minute particles stick to the "workmen's clothes and felt; and I believe, that in pickling, with "the alloy, a small quantity of silver also is separated. Even in "the coining presses, when a collar begins to wear, I have found "particles of silver about the floor, so light as to be easily blown "about with the breeze, and so small as to be scarcely worth col-

"lecting. It is true the quantity of all these losses, except that "of melting, is so minute as to be almost inappreciable; yet it is "not correct to say there is not any." Upon the whole of these items, except the filing, in which I have admitted in the Memorandum, that a very trifling amount of loss may be unavoidable (except by adopting a new process of adjustment.) I must observe, that in my Memorandum I addressed myself more to the essential characteristics of the different operations, than to the *accidental* contingencies which might accompany them; and that in showing, generally, that so far from a considerable waste being the necessary consequence of coinage, the opposite ought to be the true result, I did not think myself called upon to enter into those minutiæ of explanation which are required to meet these difficulties. I must, however, now explain, that the principles already given include all these minor exceptions. In regard to every one of the losses above referred to, except filing, a complete recovery may be made. In the Madras Mint, the sweepings of every room, rolling mills, &c. are carefully collected together, and recovery made of the silver as far as it is profitable to do so: what remains in the dross is estimated, and is included in the statement of the quantity of bullion contained in the dross before given, and *credit for it is taken in the accounts.* In regard to losses in the furnace, the sweepings of it are fully searched, and there is no possibility of metal escaping, for it cannot be volatilised. In regard to the minute quantity of silver which is dissolved together with the alloy in the pickling liquor, that also is recovered, by the simple method of inserting copper sheets.

It may be objected, however, that spite of all the sweeping and gathering of drosses, particles will remain which will defy the most elaborate search and investigation. This objection, which I look upon as the very last stronghold of resistance, I feel it to be hardly necessary to meet in support of an argument professedly directed only to the main principles of the question; but I believe that the doctrine I advocate will stand to be pushed even thus far, and that even then its truth, as applicable to the ordinary operations of a Mint, will be vindicated. But in order to perceive this, it will be necessary to enter into some little explanation, and I trust that the following illustration will show my meaning.

If a chemist makes an analysis of a mineral so accurately, that not a single particle of it is either dissipated by heat, blown away in powder, or left behind in the solutions or mixtures which may have been made of it, we may conclude that he is able to collect every particle of it again, with the exception of such minute quantities as may adhere to the different vessels he has used in the process. I assume that he has not dissipated any part of it, or allowed it to escape unnoticed, mingled with any fluid or solid matters which may have been used in his processes. These solid and liquid "*drosses*" contain nothing whatever, and none has been dissipated; the only deficiency, therefore, is that which adheres to the vessels. Let us suppose the mineral weighed 100 grains, and that the deficiency is half a grain.

A precisely similar mineral is treated exactly as before in the same vessels, and its particles are removed with precisely the same care. Can it be supposed that the deficiency will again be half a grain? Let us suppose ten minerals successively treated, and by the use of the same vessels and instruments, can it be supposed that still the half grain of imperceptible adherent matter will in each remain unaccounted for. At the end of twenty operations, there would need to be accumulated in the vessels ten grains of matter undiscoverable; not thrown away in the drosses, not dissipated, but inseparably adherent to, or absorbed by the instruments employed. Of course this is impossible. After the first or second trial, this source of deficiency must cease; for as it is almost certain that the vessels would be made equally clear of matter on each occasion, so it would follow as a consequence, that the amount of imperceptible adherence and absorption would constantly be the same; and, that after the first few trials, there would cease to be any further loss from that cause.

And the same is the case with regard to the sweeping up of successive coinages of silver or gold. The whole Mint may be looked upon as a vast laboratory, and each successive room as a large vessel for performing certain processes upon bullion passing through it. On the first occasion of a coinage of any metal, we might expect the sweeping of any and all the rooms to be partially defective, and to leave behind a certain trifling amount of unde-

tected particles; but after two or three such sweepings, it may be concluded that the room will be *saturated*, if I may use the term, and have no further capacity for holding them out of the reach of the sweeper. After this, which must happen on the first establishment of a Mint, not even the trifling loss from the minute particles which have eluded search, would be experienced. All the remaining coinages would be free from any loss, for although it is very possible that some of the particles of each might [illegible] discovery, yet if, as is probable, the total amount of latent [illegible] always remains the same, it is evident that the losses in each succeeding coinage would be replaced by recoveries from some of the former ones.

The practical advantage of this principle may, however, be lost when coinages of the precious and base metals are [illegible] nate frequently with one another, and the drosses are [illegible] ully separated. In this case, the trifling remnant of unrecovered particles of gold and silver might be confounded with that of the base metal; but this is not the state of things contemplated by me as the ordinary routine of a well conducted Mint; and even this, though certain to occasion trouble and inconvenience, ought not to be the necessary occasion of any loss.

Moreover, if the possibility of the occurrence of waste be pushed to such an extreme, it would be necessary to do the same in regard to the various causes of a surplus. I have shown, I trust satisfactorily, that on general principles, in the large way, a considerable excess ought to be met with in the operations of every Mint; arising from the fractional difference in value between the "trade assay" and the true fineness of bullion. As a set-off against any minute possible exceptions against the general principle, such as those above noticed, I might appeal to the benefit by the trifling gain in *weight*, arising from a similar cause to the above, and additional to it, viz. owing to the purchaser being given the benefit of the "turn of the scale" in weighing, as well as assay. In Madras, merchant's bullion is weighed in bars of about 1,500 tolas, and the weight is calculated to the $\frac{1}{8}$th tola, the benefit of the turn of the scale being given to Government. The gain arising from this source, if the practice were followed universally, would be in

a year's coinage, suppose of 50 lacs of Rupees, more than 200 Rupees; a sum which would, I imagine, cover more than ten times all the minute chances of loss last referred to.

I may take this opportunity of observing, in regard to the statement given in the Memorandum, (para 31,) as to the loss of weight in blanching coins, that subsequent experiments have shown that the process adopted for the separation of the grease, also carries with it a considerable quantity of oxide of copper. This circumstance explains the reason of the apparent difference stated in the Memorandum between the experience of the Madras and other Mints, as to the result of the action of the acid; for the total loss of weight in regard to blanks cut from straps laminated without the use of oil, we have found during the last settlement to amount, [illegible] oxide, to 11½ annas per mille, or 1 anna 1.8 pie per cent. [illegible] portion which does not differ in any remarkable degree from that experienced elsewhere.